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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 276

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER September 29, 1915

THE PEA APHIS WITH RELATION TO FORAGE CROPS

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By

J. J. DAVIS, Entomological Assistant, Cereal and Forage Insect Investigations

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INTRODUCTION.

The periodic occurrence of the pea aphis (*Macrosiphum pisi* Kalt.) in unusual abundance on various leguminous crops, more especially red and crimson clovers, vetches, field and garden peas, and sweet peas, has placed it among the important injurious insects of the world, for it is almost cosmopolitan and more or less injurious wherever found. In Europe it has been the subject of numerous treatises, both from the systematic and economic viewpoints, and its identity has been much confused with other closely related species. In America it seems to have made its first appearance in destructive and noticeable numbers in 1899, although it is known to have been present here for at least two decades previous, and each year since 1899 this aphis has been recorded as injurious in one or more localities in the United States.

In the present paper we have attempted especially to settle the identity of the species, an important item from the economic standpoint, and to report our extended life-history investigations, together with a summary of all the important facts, both old and new, relative to the life economy of the species.

SYNONYMY.

This aphis seems to have been first authentically described under the name *Aphis pisi* by Kaltenbach in 1843 (5),[1] although two years previous Boyer de Fonscolombe (3) described a species under the name *Aphis onobrychis*, which is still doubtfully considered synonymous with *pisi* as will be noted later. Kaltenbach placed Schrank's *Aphis ulmariae* as a synonym of *pisi*, although this arrangement on the part of that author is not comprehensible, since he was doubtless aware of its priority over *pisi*. In 1855 Koch (6) redescribed *pisi* and placed it in the genus Siphonophora, no mention being made of *ulmariae*, although in the appendix of this work (p. 328) Kaltenbach's remarks include the following:

Siph. gei Koch ist, nach Herrich-Schäffer's richtiger Vermuthung, meine *Aphis Pisi* Kalt. und *Aph. Onobrychis* B. de Fonsc. Der ältere Schrank'sche Name *Aph. Ulmariæ* verlangt jedoch von allen Dreien das Prioritätsrecht.

The name *pisi* was adopted by entomologists almost universally until comparatively recent years when *ulmariae* was more or less generally accepted.

In 1909 Dr. N. A. Cholodkovsky (9) published the results of his studies on *Siphonophora pisi* and related species, definitely settling the identity of *pisi*, and for the first time pointed out that the *Aphis ulmariae* of Schrank, which he here placed in the genus *Siphonophora*, could hardly be the *pisi* of Kaltenbach. He therefore concluded that three species had heretofore been confused with *pisi*, namely *Macrosiphum pisi*, which he had found on garden peas (*Pisum sativum*), sweet pea (*Lathyrus odoratus*) and Medicago; *M. ulmariae* auct., which occurs on meadow-sweet (*Spiraea ulmaria*); and *M. caraganae* Cholod. on *Caragana arborescens*, and gives biological and morphological differences to separate the three. Later, in the same year and in the same publication, Dr. A. Mordwilko (10) gives a lengthy treatise on this insect, which he calls *Macrosiphum pisi* Kalt., and the related species. Eight supposedly distinct species are considered and a table illustrating differences of the following species is given: *M. pisi*, *M. cholodkovskyi*, *M. portschinskyi*, *M. ononis*, *M. gei*, and *M. urticae*. Three species occur on *Spiraea ulmaria*, namely, the *ulmariae* of Schrank, which he considers as belonging to the genus Aphis; *M. cholodkovskyi*, a name given for the species referred to by Cholodkovsky and other authors discussing a Macrosiphum on *Spiraea ulmaria;* and *M. portschinskyi*, a new species. The author is evidently not settled on the identity of *M. ononis* Koch, although at the end of the paper he states that "apparently the last species (*ononis* Koch) must also be recognized as distinct." And, finally, *M. onobrychis* B. de Fonsc. is questionably placed as a synonym of

[1] Numbers (1 to 12) in parentheses refer to the Bibliography of European Literature, p. 55.

pisi. More recently has come a contribution from Prof. Fred. V. Theobald (11, 12) who considers *gei* and *ulmariae* as distinct species, thus corroborating the general conclusions of the two eminent Russian entomologists, Cholodkovsky and Mordwilko. Theobald separates these large green *pisi*-like Macrosiphums into two groups according to the structure of the tip of the cornicle: (1) Those with the tip imbricated, containing *pisi* Kalt., *loti* Theob., and *trifolii* Theob., and (2) the group of closely related species with the tip of the cornicle reticulated, including *ulmariae* Schr., *gei* Koch, and *stellariae* Schr. Further, he is of the opinion that *ononis* Koch is distinct from *pisi*. Our own studies lead us to follow Mordwilko's conclusions. Schrank's description of *Aphis ulmariae* certainly seems to indicate that he was dealing with a true Aphis and not a Macrosiphum.

In 1782 Moses Harris, in his "English Insects," (1), figures an aphis which he calls *Aphis pisum* and gives a nondescript description. Theobald (12) has placed this species as a synonym of *pisi*, but there is nothing excepting the specific name to link it with the aphidid under discussion and it must therefore be placed as a possible synonym of *pisi* but not in the sense of having priority.

In 1841 Sir Oswald Mosley (4) describes *Aphis lathyri* as follows:

> 8th Species: *Aphis lathyri*.—On the Sweet Pea beneath the leaves; colour green, becoming when old of a dark purple; antennæ longer than the body; abdomen acuminated, with tubercles nearly extending to the extremity.

There is little doubt but that this description referred to *pisi*, but even with two years' priority the name *lathyri* can hardly take precedence over the well-established name *pisi* and must be placed in the same category as Harris's *pisum*.

The correct name which should be adopted for this insect is still somewhat questionable, but at this distance we, in America, must follow largely the researches of European aphidologists. *M. pisi* Kalt. must for the present be considered as having priority, although further researches may prove *Aphis onobrychis* B. de Fonsc. to be identical, this species having two years' priority over *pisi*, as stated above. In this connection Mordwilko (10) says:

> The same species of plant louse [referring to *pisi*] was apparently described two years earlier (1841) by Boyer de Fonscolombe and named *Aphis onobrychis*, having been found on *Hedysarum onobrychis*. However, it is still premature to regard these two names as synonyms.

Walker, Buckton, Ferrari, Schouteden, Theobald, and others have made *onobrychis* a synonym of *pisi* but none has given sufficient evidence to support this conclusion. Authors discussing a plant louse on pea under the name *ulmariae* doubtless had in mind *M. pisi*, since it seems to have been fully proven that the true *ulmariae* does not feed on the hosts recorded for *pisi*. Further, we must accept

the interpretations of Cholodkovsky, Mordwilko, and Theobald that species heretofore considered as synonomous with *pisi*, namely *gei* Koch, *ulmariae* Schr., and *ononis* Koch, are good and distinct species and that *onobrychis* B. de Fonsc. is still a doubtful species.

Our own results published herein assure us of the identity of the pea aphis (*pisi* Kalt.) occurring in America and Europe. In America there seem to be only two names, originating here, which can properly be considered synonyms of *pisi* Kalt., namely *destructor* Johnson and *trifolii* Pergande.

The synonymy of *Macrosiphum pisi* Kaltenbach, as we now understand it, is as follows:

Macrosiphum pisi (Kaltenbach).
Aphis pisum Harris.
Aphis lathyri Mosley.
Aphis onobrychis B. de Fonsc.?
Aphis pisi Kaltenbach.
Siphonophora pisi Koch.
Siphonophora ulmariae Passerini (nec Schrank).
Nectarophora pisi Oestlund.
Nectarophora destructor Johnson.
Macrosiphum pisi Schouteden.
Macrosiphum trifolii Pergande.

IDENTITY OF THE SPECIES OCCURRING IN AMERICA.

Macrosiphum pisi was first reported in America by Cyrus Thomas in 1878, although this record has been incorrectly discredited by most subsequent authors. In 1900, following the first noteworthy outbreak of this pest in the United States, Johnson described the species as new, calling it *Nectarophora destructor*. The following year Sanderson reported studies to show that *destructor* is identical with *pisi* of Europe, basing his conclusions partly by comparison with specimens labeled *pisi* from Buckton. Evidently Buckton was confused on this species, since one of the species sent Sanderson was certainly not *pisi*, for the tips of the cornicles were reticulated, a character which separates *pisi* from many closely related forms. Doubtless this error on the part of Buckton led Sanderson to consider certain American species with reticulated cornicles as synonyms or varieties of *pisi*. In 1904 Pergande described a species under the name *Macrosiphum trifolii*.[1] We have had an opportunity to examine the type slide of *trifolii* Perg. and find it to be identical with *pisi*, and our determination has been verified by Mr. Pergande. Notes on the

[1] Prof. Fred. V. Theobald (Theobald, Fred. V. The British species of the genus Macrosiphum, Passerini, Pt. II. *In* Jour. Econ. Biol., v. 8, no. 3, p. 139, fig. 46, Sept. 29, 1913) has described a new species under the name *M. trifolii*, overlooking the fact that the name is preoccupied. We therefore propose for this species *Macrosiphum theobaldii* n. n. It is distinguished from *pisi*, according to Theobald, only by the usually paler green color, the absence of sensoria on antennal segment III of the wingless female, and relatively thicker antennæ, which are rather variable characters for this genus. Winged forms were not observed by Theobald. It is not improbable that this will prove to be *pisi*.

type specimens of *trifolii* are given in the descriptive paragraphs. Pergande listed a variety of hosts attacked by *trifolii*, and although we have not seen specimens other than the types which were collected on *Trifolium pratense*, we doubt the correctness of its occurring on such plants as strawberry, dandelion, wheat, and oats, food plants noted by Pergande.

Through the kindness of Dr. Albert Tullgren, of Sweden, Drs. Mordwilko and Cholodkovsky, of Russia, Prof. F. V. Theobald, of England, and Dr. G. Del Guercio, of Italy, we have been able to compare the American *pisi* with specimens from the foregoing countries and find them to be identical.

PAST HISTORY OF THE PEST AND ITS INJURIES.

IN EUROPE.

For at least a century the "green dolphin," as this insect is commonly known in England, has been a serious pest to peas, vetches, and clover. One of the earliest records of injury is that given us in 1815 by Kirby and Spence (2), who reported that in 1810 "the produce was not much more than the seed sown; and many farmers turned their swine into their pea fields, not thinking them worth harvesting. The damage in this instance was caused solely by the Aphis, and was universal throughout the kingdom, so that a supply for the navy could not be obtained."

In 1876 Buckton (7) writes that this insect "in some years is very destructive to the farm crops. It feeds on a large number of plants, but chiefly it infests the field pea, on the young shoots and leaves of which it clusters by thousands." Thus the pea aphis seems only to have been occasionally and locally injurious in England; but in 1885 that country suffered from a great plague of pea "lice," and this unusual abundance has been correlated with the slight precipitation during that year. In her report for 1885, Miss Ormerod (8) notes that this plant louse particularly damaged peas and vetch.

As has been stated by Mordwilko (10):

> In North Europe the pea louse lets itself be heard from only occasionally. For instance, Kaltenbach (1843–1872) and C. Koch (1857) mention nothing at all about damage by the pea louse. Only E. Taschenberg notes briefly that the pea louse is occasionally very injurious to peas on which it hinders the further growth of the tips of young runners.[1]

Quoting further from Mordwilko (p. 36):

> In Russia as in N. Europe field peas suffer only occasionally from pea lice, namely, when the latter succeeds to increase greatly by the time or before peas come into bloom * * *.

[1] Taschenberg, E. L. Naturgeschichte der wirbellosen Thiere, die in Deutschland sowie in den Provinzen Preussen und Posen den Feld-, Wiesen- und Weide-Culturpflanzen schadlich werden. Bremen, 1865. Also under title: Die der Landwirthschaft Schädlichen Insecten und Würmer.

IN AMERICA.

Dr. Cyrus Thomas was the first to observe and record this species from America (1878, 1879). The authenticity of this record has been doubted by most writers, but we have examined the specimens used by Thomas in drawing up his description (Davis, 1913) and find them to be the *Macrosiphum pisi* of Kaltenbach. Thomas's specimens were collected in Illinois in 1878, which is indicative of its introduction into America some years previous, possibly as much as 10 or 15 years before. Subsequently and previous to 1899, *pisi* was reported by Oestlund (1886), Smith (1890), and Williams (1891).

Macrosiphum pisi, therefore, was introduced into America fully 20 years previous to its appearance in serious numbers and here we have a case analogous to that of the gipsy moth, which was present in this country for about 25 years before it became a pest (Chittenden, 1909a).

Although the losses attributed to this aphidid have been largely to garden peas, still certain other crops have been much injured by it, the actual damage, however, never being apparent as in the case of the garden pea. Among other crops field peas are frequently injured by *pisi*. As early as 1900 Dr. Chittenden (1900b) reported injury to this crop, grown for hay, in Virginia. Mr. G. G. Ainslie records the total destruction of a plat of Canadian field peas at Nashville, Tenn., as early as February 17, in 1911.

The first positive record of injuries to clover in America by this plant louse was noted by Mr. W. G. Johnson, who wrote in 1900 that "hundreds of acres of red clover have been destroyed by it [*M. pisi*]. In one instance, reported to me June 13, 1900, Mr. C. Silas Thomas, of Lauder, Frederick County, Md., stated that the pest had almost entirely ruined 65 acres of red clover. Many other cases of a similar nature were reported or observed by us." Dr. E. D. Sanderson (1900g) reports the occurrence of a plant-louse, presumably this species, which occurred in injurious numbers on crimson clover as early as 1890. In the same paper Sanderson says:

> One of our best farmers, Mr. Frank Bancroft, of Camden, Del., tells me that he has seen what he judges to be the same louse on crimson clover for at least six or seven years [that is, about as early as 1893].

In 1900 Prof. F. M. Webster (1900) observed this insect in abundance on red clover at Wooster, Ohio. Dr. J. W. Folsom (1909) reports injury to red clover in the following words:

> In 1903 the louse killed an immense amount of red clover and weakened much more in Dekalb County [Illinois]. * * * I found on the farm of Mr. A. E. Myers, at Millbrook, August 19, 80 acres of dead clover roots in one field. Not one root in a thousand showed any signs of life, and on the ground were thousands of the cast skins of the aphid. At cutting the lice had been such a nuisance that the men objected to handling the crop. After cutting the clover never revived. In neighboring fields

there were many bare spots where the aphid had killed the clover locally, and in the growing clover were many centers of new infestation, due doubtless to migrant winged females. All of the clover in that part of the country was more or less injured; not only old clover but also the first-year growth. Returning to the same region the following summer to see the consequences of the injury, I did not stay long, for it was hard to find a field of clover anywhere. The farmers reported that the clover had been "winter killed," to their surprise, since the winter had not been a severe one and the clover had often survived worse winters.

Mr. Harold Morrison (1912), discussing the abundance of this insect in Indiana, says:

Two years ago [1910] it was so common in many clover fields near the city [Indianapolis] that the clover remained on the ground for more than a week after cutting without showing signs of curing. The clover stems were so plastered with honeydew that the moisture could not evaporate from them.

We have seen clover fields in Indiana so badly infested that the plants would be covered with the so-called "honeydew," a sticky, sweetish fluid ejected by the aphis from the anus. Walking through such an infested field, one's trousers would appear green, so thickly would they be covered by the plant-lice, and ruined by the honeydew which covered the plants. While it is seldom that fields are killed outright as described by Dr. Folsom, there can be no doubt that the heavy infestations, which are so common, have a decided weakening effect on the plant and much of the winter killing of clover can be traced back to the depredations of the pea aphis. Most probably much damage to clover has been overlooked or attributed to other causes, for while a crop may be injured on large field crops such as clover the injury will be overlooked unless the field is almost killed outright, and subsequent effects, such as the weakening of the vitality of the plants, is too often attributed to "winter killing," as Dr. Folsom has pointed out. Especially may this species be a very dangerous clover pest if the weather conditions are favorable to aphides and a long dry spell retards the growth of the clover.

CHARACTER OF ATTACK.

This aphidid prefers the young tender leaves and stems of its host, but eventually it covers the entire plant. Garden and sweet peas, being succulent plants, are seriously attacked and readily succumb to the depredations of the aphides. Clover, particularly red clover, on the other hand, is able to withstand considerable injury, but, as has been noted, even this plant is not free from serious damage; in fact entire fields of clover are sometimes destroyed.

EFFECTS ON CATTLE OF FEEDING THEM INFESTED CLOVER.

We have no definite reports of injury to cattle by feeding clover hay which has been heavily infested with aphidids; indeed, we have been informed by cattle feeders that such clover, which has a slightly

sweetish taste because of the honeydew covering it, is rather relished by cattle. Mr. Lawson Caesar (1911) reports that feeding cattle with infested vines was supposed by one farmer to be the cause of the death of some of his cattle, but there seems to be no proof and the conclusions were probably incorrect.

DISTRIBUTION AND ORIGIN.

As will be seen on the accompanying map (fig. 1), this aphidid is generally distributed over the United States and southern Canada, especially in the eastern half, where it is more or less destructive every year. It is likewise generally distributed throughout Europe. Theobald (12) reports this species from Natal, South Africa, and Dr. B. Das (in litt.) has found it plentiful in British India.

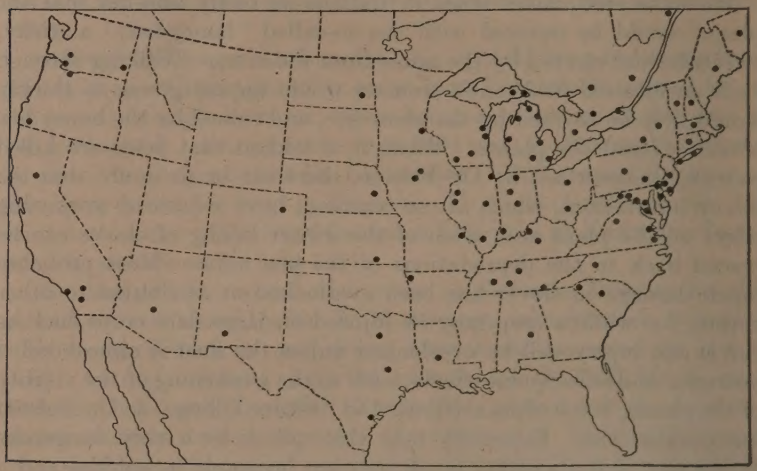

FIG. 1.—Map showing the known distribution of the pea aphis (*Macrosiphum pisi*) in America. (Original.)

As an injurious species it occurred first in America along the Atlantic coast. The following year (1900) it was very destructive in Wisconsin and Michigan, and has since worked its way westward to the Pacific coast. Recently Mr. F. C. Bishopp has sent in specimens from Texas, where it seems to have gained a strong foothold.[1]

The fact that *M. pisi* was first observed in this country within comparatively recent years and was first apparent in destructive

[1] Mr. Bishopp has kindly given the writer permission to quote his letter accompanying the specimens, under date of Aug. 4, 1914, which reads as follows:

The pea aphis was observed to be doing damage to English peas (garden peas) in experimental plats just east of Dallas, shortly after the middle of May (1914). The peas began blooming about April 30. On May 26 the growth of the peas was practically stopped and many vines turned yellow on account of the exceedingly heavy infestation of aphides. On May 31 practically all of the pea vines were dead without having produced a single pod. During the first three weeks of June, lady beetles, principally *Hippodamia convergens*, were observed to be destroying the aphides in great numbers, and a few of the pea vines were almost cleared of the "lice" and started to grow a little; however, they never made any fruit.

Mr. Bishopp further stated that the sweet peas and garden peas throughout the city of Dallas were practically destroyed.

numbers only 15 years ago is evidence that it is of exotic origin, but further evidence of the fact that it is an introduced species may be obtained by a study of the origin of its host plants. Either the sexual forms or eggs of *pisi* have been found on alfalfa (*Medicago sativa*), *M. falcata*, red clover (*Trifolium pratense*), everlasting pea (*Lathyrus sylvestris*), *Lathyrus angustifolius*, and *L. latifolius*. All of these, according to De Candolle,[1] originated in Europe, Asia, or northern Africa; indeed, all of the known cultivated hosts of *pisi* had their origin in one or the other of these continents, and from what can be learned from other writers the uncultivated host plants as well are of exotic origin. Very probably the original host of *pisi* was one of the perennials, either *Medicago sativa* or *Trifolium pratense*, or perhaps *Onobrychis sativa*, if the aphis occurring on this plant should prove to be *pisi*. Of these three hosts *M. sativa* is supposed to be the oldest in cultivation, for, according to De Candolle, it has been cultivated for more than 2,000 years, while the other two have been in cultivation less than 2,000 years. From the fact that *M. sativa* is not universally and commonly attacked by *pisi*, while *T. pratense* is, we can with reasonable certainty assume that the latter was the original host of this legume aphidid. De Candolle has shown us that *T. pratense* is a native of Europe, Algeria, and western temperate Asia, while *M. sativa* is a native of western temperate Asia, and *Onobrychis sativa* originated in temperate Europe, south of the Caucasus. Speaking further of red clover he says:[2] "*Trifolium pratense* is wild throughout Europe, in Algeria, on the mountains of Anatolia, in Armenia, and in Turkestan, in Siberia toward the Altai Mountains, and in Kashmir and the Garhwal." Of alfalfa he says (p. 103): "It has been found wild, with every appearance of an indigenous plant, in several provinces of Anatolia, to the south of the Caucasus, in several parts of Persia, in Afghanistan, in Beluchistan, and in Kashmir."

From these we may assume with a fair degree of accuracy that *Macrosiphum pisi* originated in Europe or Asia, most probably in western temperate Asia or southeastern Europe.

FOOD PLANTS.

The pea aphis commonly feeds on the clovers—especially red and crimson clover—garden, grass, Canadian field, and sweet peas, vetch, and, as will be seen later, not infrequently on alfalfa. Shepherd's-purse (*Bursa bursa-pastoris*) has been repeatedly mentioned as a host, but experiments conducted by Mr. E. H. Gibson of the cereal and forage crop insect investigations, and our own tests, have given negative results. Further the writer has examined a number of different collections of Macrosiphum from this host, invariably

[1] Candolle, Alphonse de, Origin of Cultivated Plants, p. 468. London, 1884. [2] Loc. cit., p. 105.

labeled *M. pisi* or its equivalent, and in no case has the true *pisi* been found. On the other hand, Dr. Edith M. Patch had no difficulty in getting this insect to live contentedly on shepherd's-purse. Theobald (11) lists shepherd's-purse (*Bursa bursa-pastoris*) as a host, but later in his paper says: "Colonies now and then occur on the shepherd's-purse, but I have never known them to survive any length of time." The species reported for lettuce as *M. pisi* or a variety of that species by Sanderson and others is an entirely different plant-louse. Doubtless the species collected on nettle (Urtica) and referred to this species by Oestlund is something else, and the same can be said of the records of this aphidid from beet.

In 1900 Dr. Chittenden reported tests made by Mr. Theodore Pergande to colonize this insect on the following hosts, but with negative results in each case: *Sonchus asper*, dandelion, shepherd's-purse, *Sisymbrium officinale*, and dock.

Dr. Edith M. Patch (1911) has reported a series of insectary host-plant tests for *M. pisi*, which may be briefly summarized as follows: Transfers from peas (*Pisum sativum*) to potato (*Solanum tuberosum*), to barley, wheat, oats, purslane (*Portulaca oleracea*), beets, and squash were wholly negative; from peas to red clover partially positive, and from peas to shepherd's-purse (*Bursa bursa-pastoris*) positive.

During the late summer of 1911 Mr. C. W. Creel, of this bureau, and the writer conducted a number of transfer experiments, with the following results: From red clover to cowpeas, cultivated buckwheat, wild buckwheat (*Tiniaria cristata*), wild morning-glory (*Convolvulus arvensis*), fleabane (*Leptilon canadense*), pepper-grass (*Lepidium* sp.), wheat, alfalfa, yellow sweet clover (*Melilotus officinalis*), and cinquefoil (*Potentilla* sp.), the results were negative: from red clover to soy beans were partially positive and indicated that the insect might survive and reproduce on young tender plants; from red clover to red clover, garden peas, and white sweet clover (*Melilotus alba*) the insect transferred readily and fed and reproduced contentedly. In Chicago, Ill., we found it breeding very abundantly on tender succulent shoots of *Melilotus alba* growing under greenhouse benches.

Theobald (12) attempted to colonize the species on willow, raspberry, clematis, clover, and Lathyrus, but was successful with only the two last-named plants.

Mr. C. E. Sanborn (1904) reports this aphidid from rose, but in a recent letter he writes: "*Macrosiphum pisi* has been correctly recorded as being taken on rose. I doubt, however, if rose should be considered as a regular food plant of this insect." We have repeatedly attempted to colonize *pisi* on rose, but without success, and there seems to be no reasonable question but that the specimen collected by Sanborn on rose was a stray migrant.

Mr. D. T. Fullaway (1910) reports having taken *M. trifolii* Perg. (=*pisi*) on *Sonchus oleraceus* in Hawaii, but an examination of the specimens through the kindness of Mr. Fullaway shows them to be something other than *pisi*. We have also had the privilege of examining the specimens collected and recorded by Mr. W. M. Davidson (1909) as *M. pisi* on *Urtica holosericea*, and they prove to be of another species.

We have a number of individual office records reporting *M. pisi* on alfalfa. Among these, specimens for which were examined by the writer, are the following: Mr. C. N. Ainslie collected it on this host at Prairie Grove, Ark., March 21, 1907, all stages being found. An examination of this material shows a mixture of *M. pisi* and *M. creelii*, although the former species predominates. Mr. Ainslie also collected this aphidid at Arlington, Va., April 6, 1908, on alfalfa. Mr. V. L. Wildermuth collected it on alfalfa at Holtville, Cal., April 17, 1912, and at Muirkirk, Md., April 28, 1909. At the latter place the infested alfalfa had a wilted appearance, and because of their abundance this injury was supposed to be caused by the plant-lice. Probably the most noteworthy example of *pisi* occurring on alfalfa was recorded by Mr. J. A. Hyslop, who, on November 12, 1912, observed these aphides swarming in an alfalfa field near Funkstown, Md. At this time very few viviparous forms were observed; the males and oviparous females predominated, and a few days later the black shiny eggs were found abundant on the alfalfa leaves. In this same field Mr. Hyslop observed the aphides abundant in May (1913), but in August not a single individual was found. Further observations were made in this field by Mr. C. M. Packard in October (1913), at which time the aphides were again abundant. Mr. J. T. Monell has determined as this species plant-lice collected on alfalfa at Wellington, Kans., May 4 to July 30, 1909, by Mr. E. O. G. Kelly. In all cases where this aphidid occurred on alfalfa it was found on the young terminal buds and leaves.

The following is a list of the authentic hosts of *M. pisi* as recorded in America. Although shepherd's-purse is retained as a host of this plant-louse, we have never seen specimens of this species collected on that plant. Shepherd's-purse (*Bursa bursa-pastoris*), lentil (*Ervum* sp.), sweet pea (*Lathyrus odoratus*), grass pea (*L. sativus*), alfalfa (*Medicago sativa*), white sweet clover (*Melilotus alba*), garden pea and field pea (*Pisum sativum*), crimson clover (*Trifolium incarnatum*), red clover (*T. pratense*), white clover (*T. repens*), vetches or tares (*Vicia ludoviciana*, *V. gigantea*, *V. villosa*, et al.).

The following reliable hosts have been recorded by European writers. Many of the recorded hosts, such as Geum, Ulmaria, etc., are certainly incorrect, while others are highly improbable, and as they have not been corroborated since the correct identity of *pisi* has been understood, they are not here included: Shepherd's-purse

(*Bursa bursa-pastoris*), *Chaerophyllum sylvestre*, *C. temulum*, lentil (Ervum), *Lathyrus angustifolius*, sweet pea (*L. odoratus*), *L. latifolius*, *L. pratensis*, flat pea (*L. sylvestris*), *Medicago falcata*, alfalfa or lucern (*M. sativa*), *Onobrychis* sp. (?), *Ononis repens* et spp. (?), garden pea and field pea (*P. sativum*), *Trifolium filiforme*, alsike clover (*T. hybridum*), red clover (*T. pratense*), white clover (*T. repens*), vetch (*Vicia cracca*, *V. sativa*, *V. sepium*).

Dr. B. Das, of the Government college at Lahore, India, writes (*in litt.*) under date of December 18, 1913, as follows:

> I have collected it [*M. pisi*] from Bengal, Behar, United Provinces, and the Punjab. Though not actually collected by myself, I believe it is present in other parts of India as well. What looked like a bad attack on a few plants was observed once on that beautiful flower known as "Glory flower" or "Parrot's beak" (*Clianthus dampieri*). The hosts of this species, so far known to me besides the above are: *Alhagi maurorum*, *Melilotus alba*, *Medicago sativa*, *M. falcata*, *Lathyrus odoratus* (rather bad once in Behar), *Peganum harmala*, and *Dolichos lablab*.

DESCRIPTION.

STEM-MOTHER.

Young hatching from egg, before first molt and not over 24 hours old.—Body a very pale pea green and dorsum entirely covered with a fine and uniform whitish pulverulence which gives the insect a terre verte color. Head with a dusky patch on each side of the dorsal median line, which is, however, indistinct with the pulverulent covering. Eyes black. Antennæ four-segmented and blackish green, the last segment apparently black. Legs blackish green, the distal four-fifths of the hind tibiæ covered with a bloom giving them a whitish appearance and as if covered with a mold. Cornicles blackish green, slightly paler at the base and a black ring marking the rim of the opening at apex. Cauda not visible.

Measurements of a single individual, made immediately after mounting in balsam and before shrinkage occurs: Length of body, 0.956 mm., width, 0.487; length of cornicles, 0.0695 mm., width, 0.037; antennæ (the two antennæ measured exactly alike), segment I, 0.052 mm.; segment II, 0.043; III, 0.191; IV, base, 0.078; IV, filament, 0.178; total length, 0.542 mm.

Wingless adult (fig. 2).—(Described from four specimens, Apr. 24, 1913.) Body color pale green, the abdomen bearing several dark reddish dots which are the eyes of the embryos within her body. The dorsal and ventral surfaces show a distinct reticulation in living individuals, head bearing a faint pulverulence. Eyes dark red. Antennæ more than two-thirds the length of the body but not reaching to the base of cornicles; segments I and II concolorous with head and semitranslucent, the remaining segments semitransparent with a faint brownish green tint, excepting the tips of III and IV, distal

fourth of V, distal half of VI, base and all of filament of VI, which parts are black; segment III sometimes, but not always, bearing a small inconspicuous sensorium near its base and the usual sensoria at distal end of V and VI base. Beak just reaching coxæ of second pair of legs. Legs with femur very pale green and semitransparent; tibia with basal half pale semitransparent, the distal half with a faint brownish tint and the tip black; tarsus black. Cornicles reaching tip of cauda (of the four specimens examined the cornicles reached a little beyond the tip of cauda in three specimens and not quite to the tip in the fourth specimen), concolorous with body at base, becoming paler and semitransparent toward the apex, the tip blackish; cylindrical and slender; noticeably widened at base and the tip imbricated. Cauda ensiform and typical of the genus, and concolorous with body.

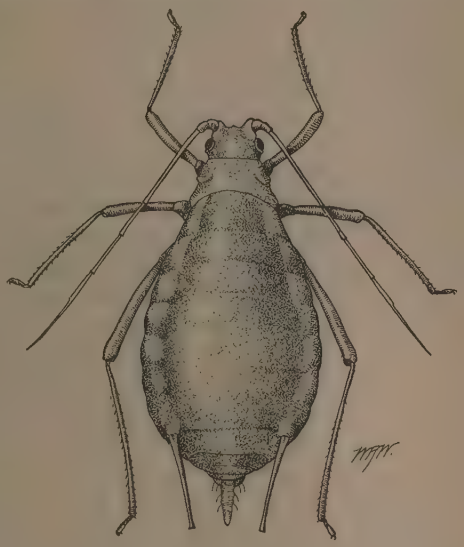

FIG. 2.—*Macrosiphum pisi:* Adult stem-mother. Much enlarged. (Original.)

Measurements from two specimens immediately after placing alive in balsam and before shrinkage occurs: Length of body, 2.63 mm., to tip of cauda, 3, width, 1.45; length of cornicles, 0.74 mm., of cauda, 0.44. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI, base.	VI, filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.156	0.069	0.695	0.348	0.469	0.235	0.522
.156	.078	.695	.348	.452	.243	.539
.139	.078	.626	.287	.400	.209	.469
.139	.087	.634	.296	.400	.209	.469

SUMMER VIVIPAROUS GENERATION.

First instar, before first molt and about 1 hour old (fig. 3).—(Described from six specimens, Aug. 20–21, 1912.) Head and thoracic segments whitish with a pale greenish tint; remainder of body pale green excepting those segments posterior to and including the segment

bearing the cornicles, which are of a decided bright yellow tint. Antennæ five-segmented, reaching a little beyond tip of body, segments I and II concolorous with head or paler, the remaining segments whitish semitransparent with the tips of III, IV, and basal part of V dusky. Eyes bright red. Legs concolorous with antennæ, excepting tarsus which is dusky. Cornicles concolorous with antennæ the tip dusky, slightly narrowed at tip, and reaching beyond tip of abdomen. Style not visible.

FIG. 3.—*Macrosiphum pisi:* First instar of viviparous generation. Much enlarged. (Original.)

Measurements from two specimens, immediately after placing in balsam and before shrinkage occurs: Length of body, 0.91 mm., width, 0.40; length of cornicles, 0.139 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V base.	V filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.06	0.05	0.19	0.18	0.087	0.39
.07	.05	.208	.208	.094	.45
.07	.05	.208	.208	.100	.45
.07	.05	.208	.208	.100	.45

Second instar, after first molt and 50 to 60 hours old.—(Described from four specimens, Aug. 19–22, 1912.) Entire body pale green; eyes red; antennæ reaching a little beyond tip of abdomen; segments I and II pale green and somewhat transparent; III, IV, and base of V pale, semitransparent, with the tips dusky; filament of VI blackish; segment III sometimes with a dusky ring near middle, but not constricted. Beak reaching coxæ of second pair of legs. Legs with femur very pale green, the tip dusky, tibia pale, becoming dusky toward tip, the tip blackish, and tarsus black. Cornicles pale, semitransparent, becoming pale dusky near apex, the extreme tip black. Cauda concolorous with body.

Measurements from two specimens, immediately after placing in balsam and before shrinkage occurs: Length of body, 1.16 mm., width, 0.53; length of cornicles, 0.25 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V base.	V filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.104	0.060	0.348	0.261	0.129	0.765
.095	.069	.330	.270	.139	.608
.104	.060	.348	.270	.139	.600
.095	.060	.348	.278	.139	.608

Third instar, after second molt and 75 to 97 hours old.—(Described from three specimens, Aug. 20–23, 1912.) Body pale green, the anterior portion, including head, slightly paler or yellowish green; some

specimens pale yellow-green at posterior end, becoming whitish green toward anterior end. Eyes maroon red. Antennæ a little longer than body; 6-segmented; segment I pale green; II pale green, with a faint brownish tint; III, IV, and V pale, sometimes with a faint brownish tint, and the tips dusky to blackish; base of VI pale brownish to dusky, becoming blackish at the tip; filament of VI blackish. Beak reaching to coxæ of second pair of legs. Legs with femur pale greenish yellow to greenish, the apex sometimes pale brownish, tibia pale with a slight duskiness and the tip blackish, tarsus black. Cornicles reaching just to or a little beyond tip of cauda. Cornicles pale green to yellowish green at base, becoming pale dusky toward apex, the extreme tip black. Cauda concolorous with body. Cornicles, cauda, and antennæ usually semitransparent.

Measurements from one specimen, immediately after placing in balsam and before shrinkage occurs: Length of body, including cauda, 1.70 mm, width, 0.64; length of cornicle, 0.40 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.12	0.07	0.278	0.278	0.370	0.174	0.73
.12	.07	.268	.295	.382	.157	.73

Fourth instar, after third molt and between 127 and 128 hours old.— (Described from two specimens, Aug. 19–24, 1912.) Body pale green, sometimes with an indistinct yellowish area at the base of each cornicle, the head and thoracic segments sparsely covered with a whitish pulverulence which gives them a paler green color. Eyes maroon red. Antennæ reaching beyond tip of cauda; segment I concolorous with head, II concolorous with head or with a faint brownish tint; III, IV, V, and base of VI pale brownish green, with the tips blackish; filament of VI blackish. Legs with femur pale green at base, becoming faintly dusky toward apex, tibia pale brownish with tip blackish, tarsus black. Cornicles reaching a little beyond tip of cauda, pale green with the tip blackish. Cauda concolorous with body.

Measurements from one specimen, immediately after placing in balsam and before shrinkage occurs: Length of body, 2 mm., length including cauda, 2.25, width, 0.92; length of cornicles, 0.61 mm.; length of cauda, 0.25 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.15	0.07	0.487	0.469	0.504	0.208	0.887
.15	.07	.504	.452	.504	.208	.887

Adult wingless viviparous female.—(Described from four specimens reared on red clover, Aug. 18–22, 1912.) (Fig. 4.) Entire body pale gradually blackening toward tip; VI dark brown to black; segment green, the anterior part, including head and usually the first and second thoracic segments, as a rule paler. The red eyes of the embryos within the body are almost always visible through the dorsal body wall. As seen through the binocular the living individual appears slightly roughened and reticulated. Eyes dark reddish brown. Antennæ (fig. 4, *a*) on prominent tubercles; reaching beyond tip of cauda; filament of segment VI the longest, it being noticeably longer than III; segments I and II concolorous with head; III and IV dusky

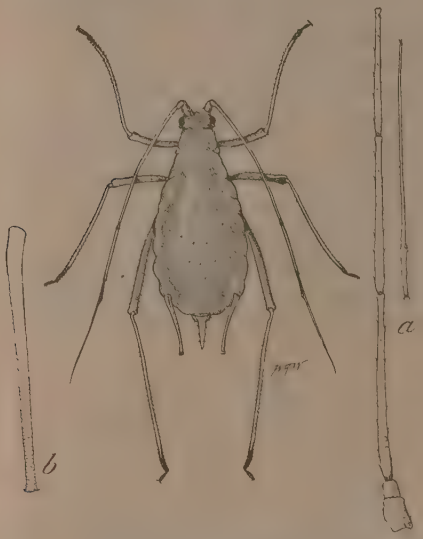

FIG. 4.—*Macrosiphum pisi:* Adult wingless female of viviparous generation, much enlarged; *a*, antenna, and *b*, cornicle, of same, more enlarged. (Original.)

greenish to pale brownish, with the tips blackish; V darker, gradually blackening toward tip; VI dark brown to black; segment III with one or two, and sometimes three, circular sensoria near the base; segments V and base of VI with the usual distal sensoria; hairs short and sparse. Beak reaching to coxæ of second pair of legs. Legs long and slender, moderately hairy; femur pale green with a slight brownish tint toward apex, joint of femur and tibia dusky; tibia pale green, with a slight brownish tint, and the tip blackish; tarsus black. Cornicles long and slender, broadest at base, tip imbricated and no sign of reticulation, just reaching to tip of cauda, pale green at base, paler or with a faint brownish tint toward apex, the extreme tip black. Cauda concolorous with body, ensiform, and

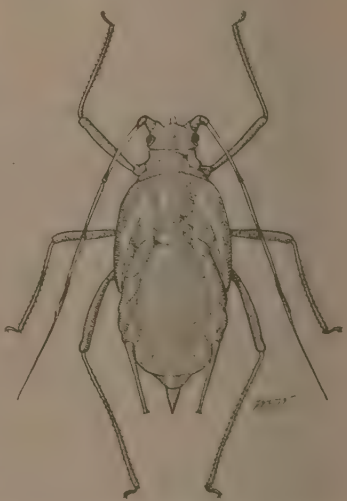

FIG. 5.—*Macrosiphum pisi:* Pupa of viviparous generation. Much enlarged. (Original.)

typical of the genus; more than half as long as the cornicles, bearing a number of moderately long hairs.

Measurements (averages) from three specimens, taken immediately after placing in balsam and before shrinkage occurs: Length of body, 2.67 mm., length to tip of cauda, 3.22; width, 1.24; cornicles, 0.98 mm.; cauda, 0.59 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI, base.	VI, filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.191	0.087	0.904	0.713	0.713	0.261	1.130
.191	.087	.930	.730	.713	.261	1.026
.191	.087	.817	.678	.696	.261	1.026
.191	.087	.800	.678	.626	.235	.974
.191	.087	.887	.696	.678	.261	.991
.174	.087	.870	.696	.696	.261	1.026

Pupa (*fourth instar*) (fig. 5).—(Described from three specimens, Aug. 22, 1912). Entire dorsum pale green, sometimes with a delicate white pulverulence. Wing pads pale greenish with faint brownish border, the tips darker brown. Underside of body with a distinct white pulverulence. Eyes maroon red. Antennæ with segments I and II concolorous with head; III, IV, and V pale with slight brownish tint and tips blackish; VI entirely blackish. Beak not reaching coxæ of second pair of legs. Legs with femur pale green, tibia pale with slight brownish tint and blackish at the tip, tarsus black. Cornicles pale green at base, becoming whitish with a faint duskiness, the tips black; cauda concolorous with body.

Measurements (average) from three specimens, immediately after placing in balsam and before shrinkage occurs: Length of body, 2.94 mm., width, 1.19; length of cornicles, 0.63 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI, base.	VI, filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.139	0.078	0.556	0.495	0.539	0.209	0.834
.139	.078	.539	.487	.548	.209	.852
.139	.069	.487	.469	.513	.209	.808
.139	.078	.461	.443	.487	.209	.817
.156	.078	.539	.522	.539	.209	.800
.148	.078	.556	.513	.565	.200	.887

Winged viviparous female (fig. 6).—(Described from three specimens reared on red clover, Aug. 22 and Dec. 11, 1912.) Head pale yellow-green, thoracic shield shining yellow-green, other parts of thorax concolorous with the head, and abdomen pale green with the eyes of the embryos showing through the skin of the dorsum as in the case of the adult wingless female. Eyes bright red. Antennæ (fig. 6, *a*) placed on large frontal tubercles, and reaching beyond tip of cauda;

filament of segment VI longest, it being noticeably longer than III; segments I and II of a darker green color than body, III with the extreme base pale, the remainder of that segment brownish with the extreme tip black; IV pale brown at base gradually changing to blackish brown toward the apex, the extreme tip black; V and VI blackish to black, bearing a moderate number of rather short, fine hairs; segment III with 11 to 22 (one apparently abnormal specimen had but 9 and 10 sensoria, respectively, on its two antennæ), with an average of 15.5 for 36 examples examined, circular sensoria arranged in a row but not extending quite to the tip, the distal one-fifth of the segment bare, the usual distal sensoria on V and base of VI. Beak

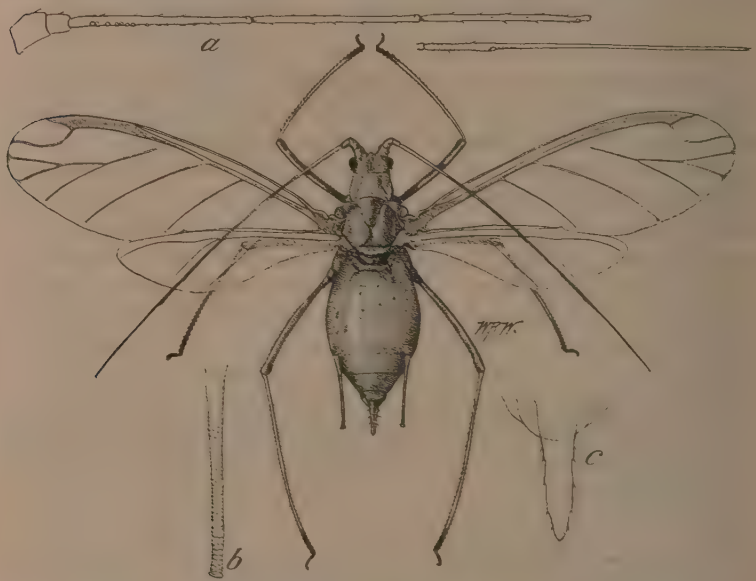

FIG. 6.—*Macrosiphum pisi:* Winged female of viviparous generation, much enlarged; *a*, antenna, *b*, cornicle, and *c*, cauda, of same, more enlarged. (Original.)

not quite reaching coxæ of second pair of legs. Wings clear, veins slender and brownish, the second branch of the media varying somewhat but usually about equidistant from tip of wing to the point where the media first branches; hind wings with normal venation. Legs long and slender; femur pale green on basal half, becoming dusky to blackish toward tip; tibia pale greenish with a faint brownish tint and the apex black; tarsus black. Cornicles (fig. 6, *b*) long and slender, reaching beyond tip of cauda, widest at the base, basal third concolorous with the abdomen, remainder dusky and the extreme tip black, imbricated, and no sign of reticulation at the tip. Cauda concolorous with the abdomen.

Measurements (average) from three specimens, immediately after placing in balsam and before shrinkage occurs: Length of body, 2.79 mm., to tip of cauda, 3.18., width, 1.11; length of wings, 3.51 mm., width, 1.16; length of cornicles, 0.84 mm.; length of cauda, 0.46 mm.; length of hind tibia, 2.32 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI, base.	VI, filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.156	0.069	0.826	0.721	0.748	0.304	1.095
.156	.078	.817	.730	.748	.296	1.061
.....	.....	1.006	.716	.735	.329	1.006
.....	.....	1.006	.677	.735	.310	.987
.....	.....	.968	.658	.658	.310	.968
.....	.....	1.045	.658	.677	.290	.....

SEXUAL FORMS.

Winged male (fig. 7).—(Described from two specimens, Dec. 4, 1912.) Head and prothoracic segment gamboge with a dusky to

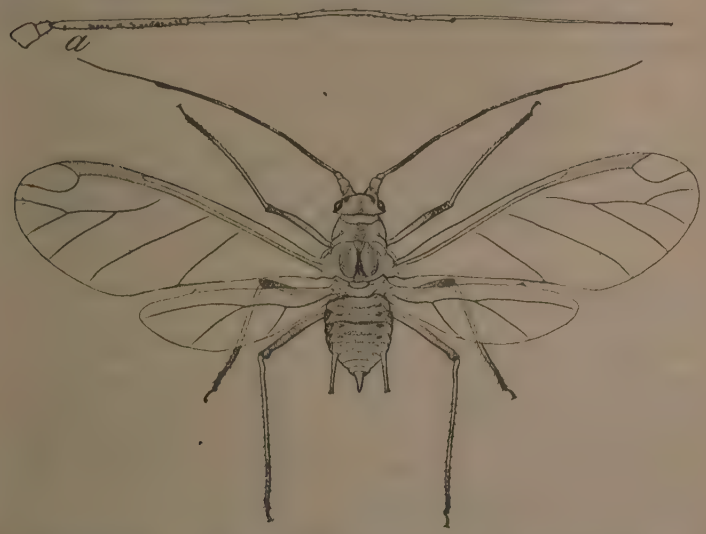

FIG. 7. *Macrosiphum pisi:* Winged male, much enlarged; *a*, antenna of same, more enlarged. (Original.)

brownish longitudinal median dorsal marking which does not extend quite to tip of head. Thoracic shield brownish with interstices concolorous with head. Abdomen pale green with pale dusky markings as shown in the illustration (fig. 7) and the segments posterior to the cornicles pale yellowish green. Eyes very dark red, almost black. Antennæ (fig. 7, *a*) noticeably longer than body; filament of VI longer than III; entire antenna blackish excepting segments I and II and

small area at base of III, which are pale dusky; sparsely covered with delicate, inconspicuous hairs; segment III bearing 40 to 50 irregularly placed circular sensoria, IV bare, V with 10 to 15 circular sensoria, not including the usual distal one, more or less in a row but more thickly placed toward the apex; base of VI with the usual distal ones. Beak whitish yellow, the tip black; reaching beyond the coxæ of the first pair of legs but not to the middle coxæ. Wings as in the viviparous female. Legs long and slender, the femur pale yellowish to yellowish green, becoming blackish on the distal third, tibia pale brown and the tip black, tarsus black. Cornicles as in viviparous forms, pale with a slight duskiness and the tip blackish. Cauda ensiform and bearing moderately long hairs as in other forms, and pale dusky to dusky in color.

Measurements of body dimensions not made from living specimens and mounted individuals are slightly shriveled. The male is considerably smaller than the viviparous female. Measurements from specimens mounted in balsam except as noted: Length of body, 1.4 mm., to tip of cauda, 1.55, width, 0.52; length of wing, 2.87 mm., width, 1.04; length of cornicle, 0.38 mm.; length of cauda, 0.20 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.156	0.069	0.696	0.539	0.626	0.217	[1] 0.852
.156	.069	.696	.547	.609	.243	[1] 1.008
.148	.069	.626	.435	.504	.217	[2] .852
.148	.069	.626	.400	.495	.191	[2] .800
.139	.069	.....	.435	.469	.174	([2])

[1] Measured immediately after placing in balsam.
[2] Specimens killed in 70 per cent alcohol, mounted in balsam the following day, and measured immediately afterwards.

Wingless male (fig. 8).—(Described from two specimens, one observed in copula, October 18, 1911.) Head dusky brown, thoracic segments and first abdominal segment pale yellowish; remainder of abdomen pale green with dusky markings as follows: One spot on each side, dorsolateral in position, on the thoracic segments and the first five or six abdominal segments, those on the first two thoracic segments very faint, the others gradually larger, those on the first three abdominal segments being transverse markings rather than simple dots, and the markings on the following abdominal segments, dots or small circular spots. Antennæ situated on prominent frontal tubercles; much longer than the body; sparsely hairy; filament of segment VI longer than III; I and II dusky brown to blackish; III black, excepting paler extreme base; IV dark brownish and black at tip; V black, excepting a small portion at the base which is brownish, and VI black; segment III bearing 47 to 57 irregularly

placed circular sensoria; IV bare; V with 14 to 18 circular ones, not including the usual distal sensorium, in a row on the distal two-thirds; base of VI with the usual ones. Beak reaching about to coxæ of second pair of legs. Legs long and slender, the femur blackish excepting basal third, which is pale; tibia pale brown except tip, which is black, and the tarsus black. Cornicles as in winged male, pale at base, becoming faintly dusky toward the tip; the apex black. Cauda pale green and agreeing with that of the winged male. Measurements (averages) from two specimens mounted in balsam, bodies slightly shriveled: Length of body, 1.55 mm., to tip of cauda, 1.72, width, 0.58; length of cornicles, 0.57 mm.; length of cauda, 0.26 mm. Measurements of antennal segments:

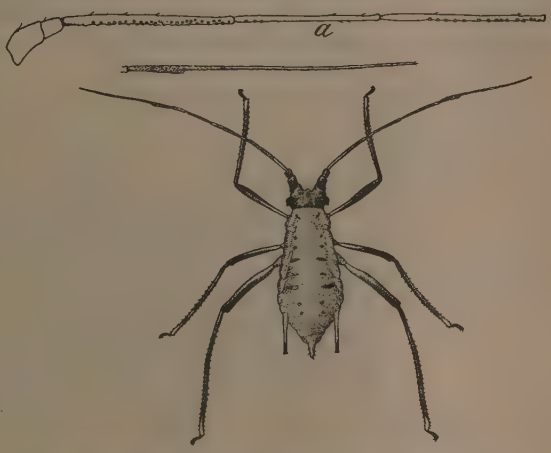

FIG. 8.—*Macrosiphum pisi:* Wingless male, much enlarged; *a*, antenna of same, more enlarged. (Original.)

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.156	0.087	0.817	0.713	0.748	0.252	1.061
.156	.087	.852	.678	.730	.261	1.009
.156	.087	.817	.651	.748	.269	.991
.156	.087	.817	.661	.739	.243	1.043

Wingless oviparous female (fig. 9).—(Described from two specimens, December 12, 1912.) General color pale pea green or even yellowish green, the head paler and the abdomen posterior to the cornicles with a yellowish tint in some individuals. The eggs within the body often show through the dorsal abdominal wall. Eyes dark red. Antennæ placed on prominent frontal tubercles; reaching to or a little beyond tip of body; very sparsely hairy; filament of segment VI longest; sensoria usually as in the wingless viviparous female, that is, only 1 or 2 sensoria at the base of segment III, but we have found exceptions where segment III bore as many as 10 sensoria in a row; segments I and II pale green or yellowish green,

the remaining segments pale with a faint greenish tint and the tips of III, IV, V, and all the base of VI dusky and filament of VI black. Legs pale green, the tips of tibia and all of the tarsus blackish, basal two-thirds to three-fourths noticeably swollen and bearing numerous small circular sensoria (fig. 9*b*); cornicles as in other forms, just reaching to tip of cauda, pale with slight greenish tint and the tip dusky to blackish. Cauda pale green or yellowish. Measure-

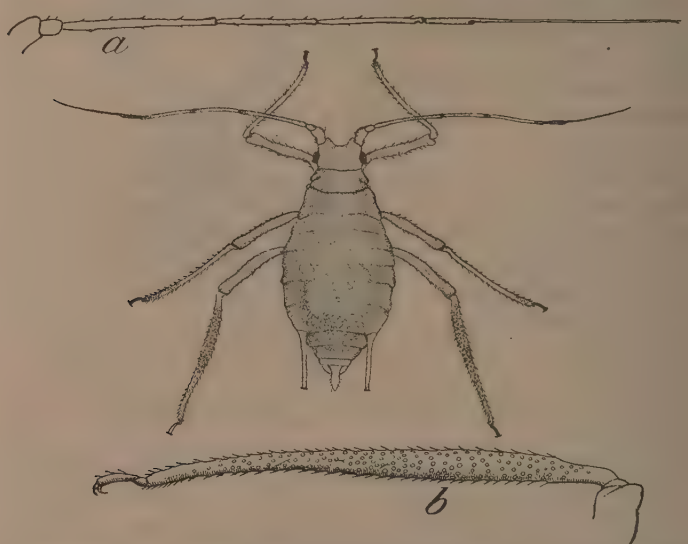

FIG. 9.—*Macrosiphum pisi:* Oviparous female, much enlarged; *a*, antenna, and *b*, hind tibia, of same, more enlarged. (Original.)

ments taken immediately after mounting: Length of body, 1.82 mm. (Another individual, apparently unfertilized, but with abdomen abnormally distended with eggs, measured 2.21 mm. in length and 1.28 mm. in width.) Length of body to tip of cauda, 1.97 mm., width, 0.93; cornicles, 0.46 mm.; cauda, 0.21 mm. Measurements of antennal segments:

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.139	0.078	0.487	0.348	0.391	0.209	0.661
.139	.078	.494	.348	.400	.209	.643
.139	.078	.696	.435	.522	.234	.817
.156	.069	.748	.435	.522	.252	.800

Egg.—The egg is pale to bluish green and shining when first laid, gradually changing to jet black. It is elliptical oval, and measures 0.75 to 0.80 mm. in length and 0.35 to 0.40 mm. in width.

Sexuparæ.—What we have supposed to be wingless sexuparæ, that is, viviparous females which give birth to the sexual forms, differ from the summer wingless viviparous females only by a larger number of sensoria borne on antennal segment III. There is no positive assurance that these are sexuparæ but all of our mounted specimens showing this character were collected in September or later. Likewise, wingless viviparous females, collected in Russia during September by Dr. A. Mordwilko and sent us by Dr. N. Cholodkovsky, bear a similar number of sensoria. Six antennæ of specimens collected at La Fayette, Ind., in October bear 10, 7, 8, 9, 13, and 16 sensoria, respectively, on segment III, and eight antennæ of specimens collected in Russia in September bear 21, 22, 14, 7, 9, 9, 9, and 10 sensoria respectively, on segment III.

Aberrant form.—In the fall it is not uncommon to find a form which has the hind tibia swollen and bearing numerous sensoria, a character of the oviparous female, but instead of eggs the body often contains living young.

DESCRIPTIVE NOTES ON TYPE OF TRIFOLII PERG.

The type slide of *M. trifolii* Perg. which we examined September 5, 1911, bears the following data on label: "7205 (Nectarophora) Macrosiphum trifolii n. sp. Perg. on clover, Charlottesville, Va., Apr. 28, 1900." There are five winged viviparous females on the slide, the bodies of which are shrunken. The second branch of the median vein branches at a distance from the tip of the wing varying from one-half or less to three-eighths the distance from the tip to where it first branches, but usually the branching is nearer to the tip than to the point where the media first branches. Cornicles imbricated over their entire length but more distinctly near tip; the tip not reticulated. From the balsam specimens the tips of the cornicles appear to have been dusky in life, the remainder concolorous with body. Measurements of the antennal segments, cornicles, and cauda were taken as follows:

Antennæ.

I.	II.	III.	IV.	V.	VI base.	VI filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.156	0.069	0.678	0.556	0.574	0.243	Broken
.156	.078	.609	.522	.539	Broken	Broken
.156	.069	.626	.487	.504	.209	0.749
.148	.069	.591	.487	(1)	(1)	(1)
.156	.069	.731	.574	.582	.226	.801
.156	.069	.757	.609	.609	.226	----------
.174	.078	.835	.661	.661	.243	.836
.156	.069	.870	.661	.661	.261	.905
.156	.069	.661	.556	.591	.209	.731
.156	.069	.661	.556	.582	235	.818

[1] Not measureable.

Antennæ—Continued.

Cornicles.	Cauda.	Number sensoria on segment III.	Cornicles.	Cauda.	Number sensoria on segment III.
Mm.	*Mm.*		*Mm.*	*Mm.*	
0.556	0.348	13	0.697	.....	12
.556	.....	16	.749	0.383	14
.574	.313	12	.749	.....	12
.591	.....	13	.678	.400	14
.697	.417	15	.697	.....	11

COMPARISON WITH THE EUROPEAN PISI.

After carefully comparing what is commonly known as *Macrosiphum destructor* or *M. pisi* in America with specimens labeled *pisi*, or its equivalent, from Russia, Sweden, England, and Italy, kindly sent us by Cholodkovsky, Mordwilko, Tullgren, Theobald, and Del Guercio, respectively, and with the complete descriptions of Mordwilko (10) and others, we can find no substantial difference and must conclude that the species occurring in Europe and America are identical. Measurements of European specimens of the wingless and winged viviparous, and wingless oviparous females, all taken from specimens mounted on slides in balsam, are given in Table I.

TABLE I.—*Measurements of European specimens of Macrosiphum pisi Kalt.*

WINGLESS VIVIPAROUS FEMALE.

Labeled—	Antennæ.								Length.		Wings.	
	I.	II.	III.	IV.	V.	VI. Base.	VI. Filament.	Number of sensoria on segment III.	Cornicles.	Cauda.	Length.	Width.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*
Macrosiphum pisi Kalt. Wye, Kent, England, on peas 26-8-'11. F. V. Theobald	0.226	0.122	1.165	0.895	0.817	0.313	1.217	2	0.852	0.748	.....	.....
	.226	.122	1.165	.939	.835	.304	.....	2	.817			
Siphonophora ulmariæ (=S. pisi Kalt.) Firenze, Italy, on Pisum sativum 8-6-1908. G. Del Guercio.	.....	.....	1.234	1.009	.835	.278	1.148	5	1.130	.713	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	1.130			
Do	.191	.104	1.304	.....	.....	.....	.....	2	1.199	.739	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	1.173			
Do	.243	.122	1.330	1.078	.878	.348	.....	2	1.338	.782	.....	.....
	.226	.122	1.330	1.095	.869	.348	1.304	3	.....			
Do	.....	.....	(?)	(?)	(?)	.330	1.304	4	1.078	.696	.....	.....
	.....	.....	1.286	1.086	.887	.313	1.338	3	1.113			
Macrosiphum ulmariæ (=M. pisi Kalt.). On Pisum arvense. Sweden. A. Tullgren	.226	.113	1.356	1.069	.878	.330	1.200	3	1.200	.800	.....	.....
	.226	.113	1.373	1.095	.921	.....	.....	5	.....			
Siphonophora pisi Kalt. Pisum sativum, Esthland (Russia). N. Cholodkovsky	.....	.....	1.130	.939	.869	.304	1.156	3	1.252	.765	.....	.....
	.....	.....	1.208	.948	.869	.330	1.182	3	1.252			
Macrosiphum pisi Kalt. On Pisum sativum 1/14 VIII '09. Gouvern, Pskow, Russia. A. Mordwilko. Received from N. Cholodkovsky	.....	.....	1.165	.835	.800	.313	1.043	3	.835	.....	.....	.....
	.....	.....	1.148	.800	.800	.296	1.043	2	.835			
Do	.226	.122	1.286	1.078	.965	.313	1.321	3	.974	.783	.....	.....
	.209	.113	1.252	1.043	.974	.313	1.286	3	.974			

[1] Tip shriveled.

[2] Measurements of segments III, IV, and V combined, 3.355 mm.

TABLE I.—*Measurements of European specimens of Macrosiphum pisi Kalt*—Contd.

WINGED VIVIPAROUS FEMALE.

Labeled—	Antennæ.								Length.		Wings.	
	I.	II.	III.	IV.	V.	VI. Base.	VI. Filament.	Number of sensoria on segment III.	Cornicles.	Cauda.	Length.	Width.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*
Macrosiphum pisi Kalt. On sweet peas 20–9–'12. England. F. V. Theobald	0.191	0.113	1.069	0.930	0.843	0.313	1.182	29	0.748	0.539	4.41	1.62
	.191	.113	1.060	.913	.852	.330	1.182	25	.765			
Macrosiphum ulmariæ (=pisi Kalt). On Pisum arvense. Sweden. A. Tullgren	.208	.113	1.148	.991	.817	.321	.....	21	.956	.608	.....	.....
	.208	.113	1.113	.....	.....	.....	.....	21	.904			
Macrosiphum pisi Kalt. On Pisum sativum, 1/14 VIII '09. Gouvern, Pskow, Russia. A. Mordwilko. Rec'd from N. Cholodkovsky	.208	.104	1.061	.913	.817	.313	1.304	22	1.008	.608	4.45	1.55
	.208	.096	1.078	.965	.817	.330	1.278	26	.991			
Macrosiphum pisi Kalt. On Lathyrus sp., Oct., 1903. Warschau, Russia. A. Mordwilko. Rec'd from N. Cholodkovsky	.174	.104	[1] 1.061	1.095	.904	.330	[2] 1.061	26	.782	.556	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.800			

WINGLESS OVIPAROUS FEMALE.

Macrosiphum pisi Kalt. On Lathyrus sp., Oct., 1903. Warschau, Russia. A. Mordwilko. Rec'd from N. Cholodkovsky	0.191	0.104	0.982	0.721	0.765	0.295	1.043	2	0.713	.....	.....	.....
	.191	.104	.956	.730	.756	.269	1.043	2	.....			
Do	.191	.113	1.113	.782	.748	.313	1.061	2	.800	.....	.....	.....
	.191	.104	1.130	.765	.748	.295	1.061	4	.....			

[1] Upturned, and measurements only approximate.

In no case, in specimens included in this table, were sensoria present on antennal segments IV and V, excepting the usual distal one on V; the cornicles were imbricated throughout, there being no reticulation at the tips. The hind tibiæ of the oviparous females bore numerous sensoria as is the case with specimens occurring in America. Figure 10, *a–d* were made from specimens collected by Dr. A. Mordwilko in Russia and sent us by Dr. N. Cholodkovsky.

We have not had an opportunity to examine specimens of the wingless or winged males from Europe but our specimens of the wingless male agree in every particular with the description given by Mordwilko (10).

LIFE HISTORY.

The life history of the pea aphis is quite simple, for it does not have a true alternate host like some species of plant-lice. As has been noted, it attacks leguminous plants primarily, some of which are annuals, others perennials. Clovers, particularly red and crimson clovers, serve as hosts for this insect the entire year, and it is on these plants that it usually passes the winter, either as eggs or as viviparous females, although during the summer months the migrants also pass to other leguminous crops, such as sweet pea, garden and field peas, and vetches, and on these they multiply very rapidly, oftentimes destroying large acreages. In the latitude of La Fayette, Ind., the species winters both as living viviparous females, usually wingless, and as eggs. Farther north it may winter exclusively in the egg stage, although our observations are not complete on this point,

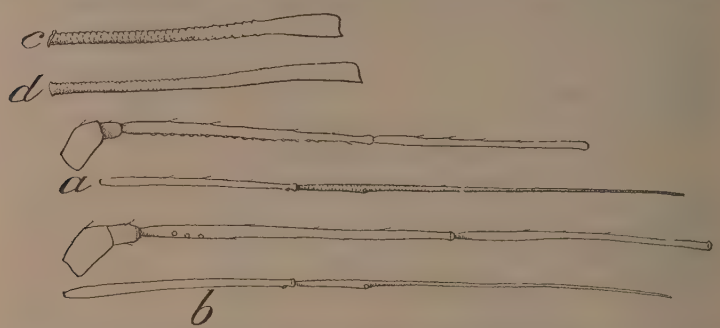

FIG. 10.—*Macrosiphum pisi* from Russia: *a*, antenna of winged viviparous female; *b*, antenna of wingless viviparous female; *c*, cornicle of winged viviparous female; *d*, cornicle of wingless viviparous female. Greatly enlarged. (Original.)

while farther south, in the latitude of Tennessee, the sexual forms which lay the overwintering eggs are rare, the insect ordinarily passing the winter as living plant-lice, both wingless and winged forms being able to withstand the lower temperatures in that latitude. Still farther south we know only the viviparous females and our observations lead us to believe that the species may reproduce viviparously indefinitely in localities where the winters are quite mild.

FIELD OBSERVATIONS.

In the latitude of Illinois, Indiana, Maryland, and Delaware migrants from the winter hosts, namely, red clover and crimson clovers, begin to spread to new fields of clover and to garden peas about May 1, and the injury to these crops usually becomes noticeable about June 1, extending up to July. Ordinarily by this time the parasitic and predacious enemies have become sufficiently numerous

to control, or at least hold in check, the aphides, and a little later, usually depending on the climatic conditions, the aphidid fungus (*Empusa aphidis*) becomes prevalent, so much so, in fact, that the plant-lice are often apparently completely exterminated. However, as the weather conditions become more favorable for the aphis and less for the fungous disease and the aphidid parasites, the few survivors are soon able to cover the plants with their progeny, so that by September we ordinarily find them again abundant on clover and late garden peas.

Farther north the insect does not seem to appear in injurious numbers until later—that is, not until about July. The following records of injury for 1899 recorded by Dr. Chittenden (1900) illustrate this statement. The first record was for Gloucester County and Portsmouth, Va., on May 17; Maryland, May 23; Newark, Del., June 2; East Hampton, Conn., July 3; Long Island, N. Y., July 7: Orono, Me., July 28; Ontario and Nova Scotia, Canada, August 9.

GENERATION EXPERIMENTS.

We have carried on generation experiments with this species through two years (1912 and 1913) at La Fayette, Ind., and the following notes were made at La Fayette, except as indicated. The same general methods, as well as the cages and rearing shelters, heretofore used by the writer and described and figured in Technical Series Bulletin No. 25, Part II, of the Bureau of Entomology, have been adopted. The writer here expresses his appreciation of the services rendered by Messrs, C. W. Creel and A. F. Satterthwait, both of the Cereal and Forage Crop Insect Investigations, who attentively cared for the experiments during the absences of the writer in 1912 and 1913, respectively.

In 1913 eggs began to hatch on March 31 and from that date until January, 1914, there was obtained, out of doors, a maximum of 19 generations, no sexual forms being produced in the first-born generation series. On the other hand, following down "the last-born of the last-born" generation series, a minimum of 7 generations was obtained, the last generation consisting of males. The last generation, in this case, was really the twelfth generation from the egg, for a break in the first series of last-born generations made it necessary to substitute with the last-born of a later generation. Thus we obtained an average of 13 generations for the year. (See Table II.)

TABLE II.—*First and last generation series of Macrosiphum pisi from egg, March 31, 1913, La Fayette, Ind.*

Date.	Temperature.[1]		First-born generation series.																	Last-born generation series.										
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	Eighteenth generation.	Nineteenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.
1913.	° F.	° F.																														
Mar. 31	56	?	a																													
Apr. 1	64	34	0																													
Apr. 2	75	45	0																													
Apr. 3	74	60	0																													
Apr. 4	62	41	0																													
Apr. 5	56	33	0																													
Apr. 6	55	29	0																													
Apr. 7	48	32	0																													
Apr. 8	47	33	0																													
Apr. 9	48	39	0																													
Apr. 10	61	46	0																													
Apr. 11	46	41	0																													
Apr. 12	41	37	0																													
Apr. 13	54	37	0																													
Apr. 14	62	35	0																													
Apr. 15	67	35	0																													
Apr. 16	71	30	0																													
Apr. 17	79	46	0																													
Apr. 18	80	48	0																													
Apr. 19	68	42	0																													
Apr. 20	66	35	0																													
Apr. 21	72	38	0																													
Apr. 22	83	47	0																													
Apr. 23	81	58	0																													
Apr. 24	81	61	2	b																												
Apr. 25	77	49	6	0																												
Apr. 26	56	44	1	0																												
Apr. 27	64	32	1	0																												
Apr. 28	53	40	0	0																												
Apr. 29	76	38	4	0																												
Apr. 30	83	43	3	0																												
May 1	90	48	6	0																												
May 2	89	53	6	0																												
May 3	87	58	8	0																												
May 4	82	62	4	0																												
May 5	83	63	7	0																												
May 6	84	54	5	0																												

| | | |

TABLE II.—*First and last generation series of Macrosiphum pisi from egg. March 31, 1913, La Fayette, Ind.*—Continued.

Date.	Temperature.		First-born generation series.																			Last-born generation series.									
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	Eighteenth generation.	Nineteenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.
1913.	° F.	° F.																													
June 20	101	66			0	2	2	0															3								
June 21	95	70			0	3	4	0															4								
June 22	84	62			0	0	5	4	b														1								
June 23	75	63			0	1	2	5	0														1								
June 24	81	(?)			0	0	3	7	0														1								
June 25	83	72			0	0	3	5	0														6								
June 26	86	69			0	0	4	9	0														0								
June 27	93	71			0	0	2	4	0														0								
June 28	94	75			0	0	1	6	0														2	b							
					90	111																									
June 29	95	74					0	5	0														0	0							
																							92								
June 30	94	76					0	6	0															0							
July 1	94	75					2	6	4	b														0							
July 2	90	71					3	2	6	0														0							
July 3	90	73					3	4	4	0														0							
July 4	92	74					0	2	2	0														0							
July 5	93	74					0	3	5	0														0							
July 6	95	66					0	0	3	0														0							
							59																								
July 7	84	60						0	3	0														0							
								68																							
July 8	92	65							1	0														0							
July 9	94	66							1	0														0							
July 10	90	61							3	0														0							
July 11	85	57							3	0														0							
July 12	89	70							0	0														0							
July 13	88	63							3	0														0							
July 14	90	67							1	0														0							
July 15	94	70							0	0														0							
July 16	92	76							0	0														0							

| | | |

TABLE II.—*First and last generation series of Macrosiphum pisi from egg, March 31, 1913, La Fayette, Ind.*—Continued.

Date.	Temperature.		First-born generation series.																			Last-born generation series.										
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	Eighteenth generation.	Nineteenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.
1913.	° F.	° F.																														
Aug. 27	92	69											3	5	0																10		
Aug. 28	94	66											1	4	0																3		
Aug. 29	94	53											4	3	0																9		
Aug. 30	78	53											0	4	0																2		
Aug. 31	82	62											2	3	0																6		
Sept. 1	83	69											6	5	0																6		
Sept. 2	97	67											0	2	0																7		
Sept. 3	98	68											0	4	8	b															3		
Sept. 4	98	69											0	3	7	0															4		
Sept. 5	86	64											0	2	5	0															4		
Sept. 6	91	70											0	7	5	0															5		
Sept. 7	95	71											0	2	8	0															6		
Sept. 8	92	64											0	1	3	0															3		
													70																				
Sept. 9	96	53												1	3	0															1		
Sept. 10	79	50												0	2	1															1		
Sept. 11	85	57												2	6	5	b														1		
Sept. 12	90	61												1	2	5	0														0		
Sept. 13	71	52												0	3	2	0														0		
Sept. 14	70	48												0	5	1	0														0		
Sept. 15	72	50												0	3	5	0														1	b	
Sept. 16	69	50												0	2	2	0														0	0	
Sept. 17	76	67												0	4	2	0														0	0	
Sept. 18	73	58												0	2	4	0														0	0	
																27															75		
Sept. 19	73	52												0	3		0															0	
Sept. 20	70	55												0	2		0															0	
Sept. 21	55	45												0	0		0															0	
Sept. 22	50	42												0	0		0															0	
Sept. 23	52	37												0	0		1	b														0	
Sept. 24	76	54												0	0		7	0														0	
Sept. 25	82	52												0	0		5	0														0	
Sept. 26	81	51												0	0		6	0														0	
Sept. 27	58	38												0	0		1	0														0	
														57																			

| | | |

TABLE II.—*First and last generation series of Macrosiphum pisi from egg, March 31, 1913, La Fayette, Ind.*—Continued.

Date.	Temperature.		First-born generation series.																		Last-born generation series.										
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	Eighteenth generation.	Nineteenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.
1913.	° F.	° F.																													
Nov. 16	42	38															0			0											
Nov. 17	52	38															0	2	10	0											
Nov. 18	64	47															0			0											
																	104														
Nov. 19	64	58																7	6	0											
Nov. 20	67	58																3	0	0											
Nov. 21	68	56																0	2	0											
Nov. 22	71	60																0	0	0											
Nov. 23	77	42																0	0	3	b										
Nov. 24	49	34																0	0												
Nov. 25	65	33																0	0	4	0										
Nov. 26	50	42																0	0	2	0										
Nov. 27	51	46																0	0	3	0										
Nov. 28	57	48																0	0		0										
Nov. 29	57	55																0	1	4	0										
Nov. 30	59	55																0			0										
Dec. 1	59	51																0	0	7	0										
Dec. 2	60	52																0	0		0										
Dec. 3	56	50																0			0										
Dec. 4	51	38																0	3	4	0										
																		96													
Dec. 5	50	37																	2	1	0										
Dec. 6	58	41																			0										
Dec. 7	56	32																	0	1	0										
Dec. 8	32	19																	0	0	0										
Dec. 9	39	29																	0	0	0										
Dec. 10	47	32																	0	0	0										
Dec. 11	47	26																	0	0	0										
Dec. 12	52	29																		0	0										
Dec. 13	54	30																	2	0	0										
Dec. 14	56	32																													

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TABLE III.—*First and last generation series from an individual Macrosiphum pisi collected in the field May 15, 1912, La Fayette, Ind.*

Date.	Temperature.[1]		First-born generation series.																	Last-born generation series.								
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.
1912.	°F.	°F.																										
May 15	65	46½	a																									
May 16	56	47½	0																									
May 17	67½	47	0																									
May 18	72	45½	0																									
May 19	73+	61	0																									
May 20	82½	.....	0																									
May 21	84	64	0																									
May 22	86	62	0																									
May 23	87½	67½	0																									
May 24	82	67	12																									
May 25	78½	60																										
May 26	83	56	10																									
May 27	89	66																										
May 28	81½	63	2																									
May 29	74	51	2	b																								
May 30	62	49																										
May 31	78	53	3	0																								
June 1	85	57½		0																								
June 2	87	61	9	0																								
June 3	77½	55		0																								
June 4	80	58		0																								
June 5	79	52		0																								
June 6	82	63	6	0																								
June 7	71	48		0																								
June 8	71	44	4	0																								
June 9	83	46		0																								
June 10	76½	53	4	0																								
June 11	81	55		7	b																							
June 12	85	58	5	4	0																							
June 13	80	56½	2	1	0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	b							
June 14	78	61	0	5	0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0							
			59																									

Issued July 29, 1912.

United States Department of Agriculture,

OFFICE OF THE SECRETARY.—Circular No. 40.

THE PRESENT OUTBREAK OF THE FALL ARMY WORM AND RECOMMENDATIONS FOR ITS CONTROL.

The Department of Agriculture is using all the means at its disposal to meet the emergency caused by the very great destruction of crops in the South by the fall army worm. This insect is present in unprecedented numbers from Louisiana and Arkansas eastward to the Atlantic Ocean, and is destroying corn, cotton, sugar cane, rice, and other crops to such an extent as to cause great anxiety on the part of planters and others. By means of an emergency appropriation by Congress it is possible for the Department to render quick assistance.

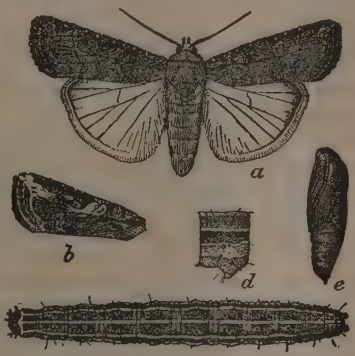

FIG. 1.—The fall army worm (*Laphygma frugiperda*): *a*, Moth, plain gray form; *b*, forewing of Prodenia-like form; *c*, larva extended; *d*, abdominal segment of larva, lateral view; *e*, pupa, lateral view. *d*, Twice natural size; others enlarged one-fourth. (From Chittenden.)

Plans for this work, in cooperation with the States concerned, are being rapidly perfected. The insect will undoubtedly continue its ravages for some time unless checked. In all probability another brood will appear after the present one transforms in the ground. For these reasons immediate action toward destroying the worms is strongly advised.

The Department recommends the use of arsenicals. Among these are arsenate of lead, Paris green, and London purple. In most cases it will be best to apply these poisons in dry forms instead of with water. Dry applications can be made by sifting the poisons upon the plants through light cloth sacks or by means of blowers or dusting machines. Liquid applications must be made with spraying apparatus to be effective. For this reason the dry applications meet the present emergency better than liquid ones.

Arsenate of lead in powdered form is recommended above all other arsenicals because it will not injure the foliage of any of the field crops grown in the South. It may be applied without the addition of any carriers. Paris green is next in effectiveness, but should be mixed with its weight of air-slaked lime or flour to prevent burning of the foliage, which is likely to occur if it is applied undiluted. London purple may be used, but should be applied with air-slaked lime or flour, as recommended in the case of Paris green. Wherever it is feasible to use liquid sprays, arsenate of lead in powdered form should be used at the rate of 3 pounds per barrel of water. Paris green should be used at the rate of about 10 ounces per barrel. It is best in case Paris green is used in this way to add 2 pounds of freshly slaked lime to prevent burning.

Whether dry or liquid preparations are used it is extremely important that the applications be made with thoroughness. In the case of

corn, some of the poison should be placed in the heart of the plant, where the greatest damage is done. A small amount is all that is required to kill insects. In the case of cotton, powdered arsenate of lead should be applied at the rate of about 5 pounds per acre. The usual method of utilizing cloth sacks carried through the field on horseback is perfectly adapted to this crop.

On forage crops and others in the case of which unfortunate results might follow the use of arsenicals, other expedients must be adopted. In pastures and in some instances on alfalfa many of the worms can be destroyed by the use of rollers or drags. In alfalfa that would be injured by rolling or dragging, the plants should be cut for hay. When the worms are forced from the fields by this means, many can be killed by means of drags or by plowing them under when they make their way to other fields. Immediately after cutting, alfalfa fields should be thoroughly disked. This will kill many of the worms before they can leave and will break up and destroy the cells of those that have gone into the ground for pupation.

The method of destroying the insects when they are in the quiet stage in the ground, to which reference has just been made, is of importance next to the use of arsenicals in checking the pests. In fact, in many cases it is by far the most effective means that can be followed.

For fields threatened with invasion but not actually attacked, a deep furrow should be plowed out around the entire circumference of the field; into this the caterpillars will fall, when they may be crushed by dragging a heavy log through the furrow. If the soil is such as to be somewhat impervious to water, this furrow may be kept partly filled with water, on the surface of which a small quantity of kerosene may be poured, which will kill the worms almost immediately when they come into contact with it.

Since the worms seem invariably to consume the grass and other vegetation growing in fields before attacking either corn or cotton, it should prove an important method of protection to spray or dust grass and weeds in cornfields threatened with attack with arsenate of lead according to the methods advised above.

Throughout the greater part of the South there is likely to be another destructive brood of the army worm which will come from the transformation of the present generation in the soil. Therefore every effort should be made to break up the pupal cells, so that the next brood will not appear. This can be accomplished by the use of plows, cultivators, and harrows. Wherever any crop which can be tilled has been injured by the fall army worm it is advised that further injury be prevented by the use of cultivators and harrows. Much good can also be accomplished by plowing fields or portions of fields where all of the crop has been destroyed. The treatment of bare places about cultivated fields in this way will be of assistance.

To summarize the situation, the Department recommends the speedy application of arsenical poisons and the working of the ground wherever practicable, in order to prevent further damage.

Warning.—Great care should be taken that cattle and other stock are kept from pasturing in the fields where the grass or other crops have been poisoned with arsenicals; also, that poisoned plants are not fed to stock.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *July 29, 1912.*

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TABLE III.—*First and last generation series from an individual Macrosiphum pisi collected in the field May 15, 1912, La Fayette, Ind.*—Continued.

Date.	Temperature.		First-born generation series.																Last-born generation series.								
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation
1912	°F.	°F.																									
July 24	91	76							8	0												7					
July 25	93	71							6	0												5					
									17																		
July 26	86½	61								0												4					
July 27	78	57								0												4					
July 28	81	63								0												4					
July 29	79½	66								0												4					
July 30	81	59								0												3					
July 31	81	61								0												2					
Aug. 1	71	52								0												3					
Aug. 2	74½	56								5	b											4					
Aug. 3	73	50								3	0											1					
Aug. 4	71	49								3	0											1					
Aug. 5	72	47								3	0											1					
Aug. 6	76	60½								7	0											1					
Aug. 7	81	65½								6	0											0					
Aug. 8	75	67½								6	0											3					
Aug. 9	81	69								5	0											2	b				
Aug. 10	73	61								0	0											0	0				
Aug. 11	76	63½								4	6	b										0	0				
Aug. 12	81	59								7	9	0										0	0				
Aug. 13	82	68								1	12	0										0	0				
Aug. 14	86	66								2	12	0										0	0				
																						63					
Aug. 15	88½	62								5	8	0											0				
Aug. 16	84	62								2	9	0											0				
Aug. 17	87	65								1	12	0											0				
Aug. 18	91½	70								3	8	2	b										8				
Aug. 19	91	70								3	4	8	0										6				
Aug. 20	99½	69								2	5	11	0										4				
Aug. 21	85	68								3	3	9	0										5				
											88																

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TABLE III.—*First and last generation series from an individual Macrosiphum pisi collected in the field May 15, 1912, La Fayette, Ind.*—Continued.

Date.	Temperature.		First-born generation series.																		Last-born generation series.								
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.
1912.	°F.	°F.																											
Sept. 30	77	33														1	0										0	
Oct. 1	75	44														1	0										0	
Oct. 2	79½	39														0	0										0	
Oct. 3	80½	47½														3	0										0	
Oct. 4	72	44														5	0										0	
Oct. 5	79	46														3	0										0	
Oct. 6	84½	59														3	0										0	
Oct. 7	85½	52														2	0										0	
Oct. 8	59	41														3	0										0	
Oct. 9	68	45														4	0										0	
Oct. 10	76½	63														4	1	b									0	
Oct. 11	67	51														3	8										0	
Oct. 12	82	39														3	10	0									0	
																50												
Oct. 13	58½	35															2	0									0	
Oct. 14	64	38															1	0									5	
Oct. 15	63	38															2	0									3	
Oct. 16	66½	41																0									3	
Oct. 17	71	49															7	0									2	
Oct. 18	74	42															7	0									8	
Oct. 19	65½	37															3	0									1	
Oct. 20	54	41															1	0									2	
Oct. 21	66	52															5	0									4	
Oct. 22	78	41															7	0									5	
Oct. 23	57	32															1	0									0	
Oct. 24	51	32															1	0									1	
Oct. 25	58	34															2	0									2	
Oct. 26	65	38															3	0									2	
Oct. 27	66	45															1	0									1	
Oct. 28	72	45															3	0									1	
Oct. 29	73	50															6	0									9	
Oct. 30	74	36															3										0	
Oct. 31	58	38															1	8	b								4	
Nov. 1	45	36															1										1	

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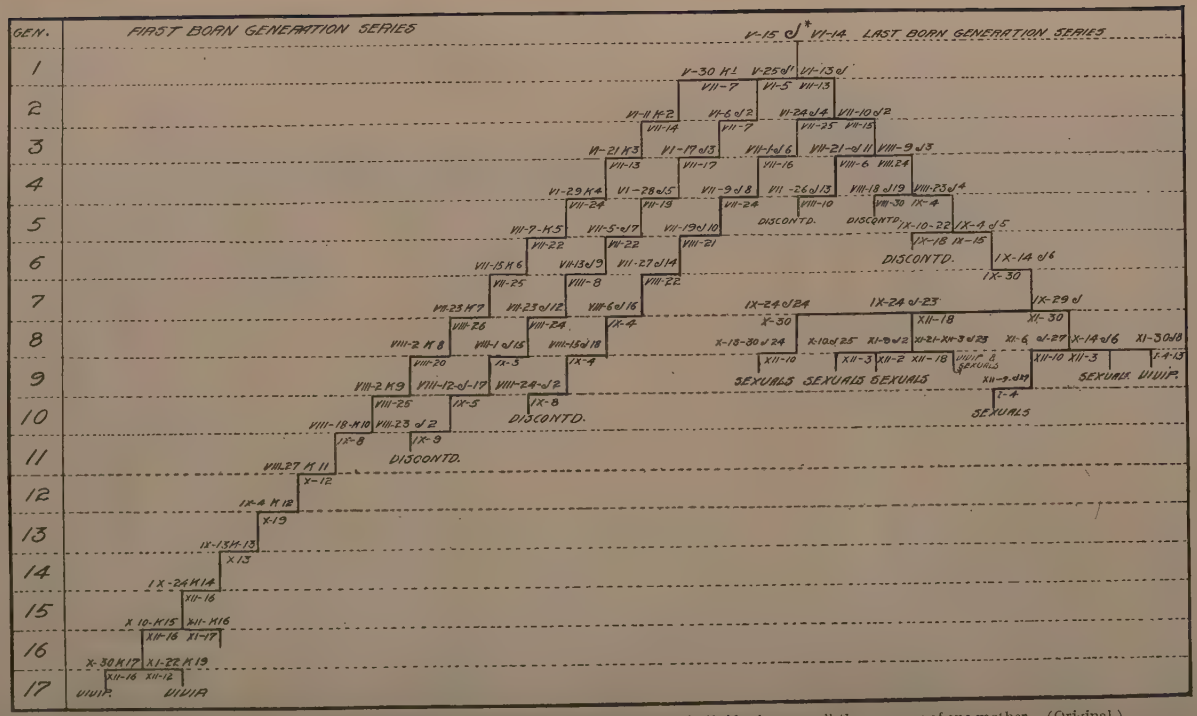

FIG. 11.—Graphic illustration of line of generations of *Macrosiphum pisi* in 1912 and individual cages, all the progeny of one mother. (Original.)

[* Immature individuals (probably second generation from egg) collected in the field May 15, 1912. Roman numerals indicate month, followed by day and cage number. Figures above line, date of birth and cage number; below line, date of death.]

Figure 11 shows graphically the lines of generations carried through in 1912 and the different individual experiments in each generation, including the cage number and dates of birth above the line and the date of death or termination of the experiment below the line, for each cage record. Figure 12 shows the length of each generation of the same series (1912).

Thus it will be noticed that the first generation in the series (probably the second generation from the egg) was the shortest, while the ninth generation was the longest, extending over a period of 156 days. Likewise it will be seen that on June 1 two generations coexisted; on July 1, four generations, from the second to the third; on August 1, seven generations, from the third to the ninth, inclusive, and on September 1, eight generations, from the fifth to the twelfth.

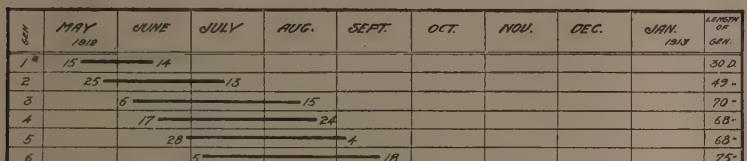

FIG. 12.—Periods and succession of generations in *Macrosiphum pisi*, La Fayette, Ind., 1912.

* This is the first generation found in the field and is probably about the third from the egg.

HATCHING OF THE EGG.

At La Fayette, Ind., the eggs of *M. pisi* hatch the latter part of March; in the cases recorded in 1913 they hatched March 31. Folsom (1909) records the hatching of eggs at Urbana, Ill., March 23, in 1905.

MOLTING.

According to our experiments this plant louse, like others of this family of insects, has five instars and never molts more than four times. In 1905 Mr. R. L. Webster, then an assistant of Dr. S. A. Forbes, State entomologist of Illinois, observed 10 individuals, all of which molted four times, although Mr. J. P. Gilbert, at the same laboratory, claims to have observed an individual molt five times (Folsom, 1909). Table IV gives our detailed records.

TABLE IV.—*Records of molts of Macrosiphum pisi. La Fayette, Ind., 1912.*

	Date of first molt.	Period between birth and first molt.	Date of second molt.	Period between first and second molts.	Date of third molt.	Period between second and third molts.
1911.		*Hours.*		*Hours.*		*Hours.*
11.00 a. m., Aug. 14.	7.30 p. m., Aug. 15.	32½	11.30 a. m., Aug 17.	40	Died	
1.00 p. m., Aug. 14.	5.30 a. m., Aug. 16.	40½	1.30 p. m., Aug. 17.	32	do	
11.00 a. m., Aug. 14.	8.00 a. m., Aug. 16.	45	Died			
3.30 p. m., Aug. 14.	5.30 a. m., Aug. 16.	38	7.00 p. m., Aug. 17.	37½	5.30 a. m., Aug. 19.	34½
3.00 p. m., Aug. 14.	5.30 a. m., Aug. 16.	38½	4.30 p. m., Aug. 17.	35	5.30 a. m., Aug. 19.	37
4.30 p. m., Aug. 14.	12.00 m., Aug. 16.	43½	5.30 p. m., Aug. 17.	29½	5.30 a. m., Aug. 19.	48
4.30 p. m., Aug. 14.	12.00 m., Aug. 16.	43½	9.00 a. m., Aug. 18.	45	5.30 a. m., Aug. 20.	44½
6.00 p. m., Aug. 14.	12.00 m., Aug. 16.	42	7.00 p. m., Aug. 17.	31	5.30 a. m., Aug. 19.	34½
9.00 a. m., Aug. 15.	5.15 a. m., Aug. 17.	44½	5.30 a. m., Aug. 18.	24½	11.30 a. m., Aug. 19	30
9.45 a. m., Aug. 15[1].	5.15 a. m., Aug. 17.	43½	6.30 a. m., Aug. 18.	25½	2.30 p. m., Aug. 19.	32
10.00 a. m., Aug. 15.	5.15 a. m., Aug. 17.	43½	5.30 a. m., Aug. 18.	24½	2.30 p. m., Aug. 19.	33
10.15 a. m., Aug. 15.	6.00 a. m., Aug. 17.	43¾	9.00 a. m., Aug. 18.	27	3.30 p. m., Aug. 19.	30¼
4.30 p. m., Aug. 18.	1.00 p. m., Aug. 20.	44½	11.45 a. m., Aug. 22.	46¾	3.30 p. m., Aug. 24.	51¾
4.30 p.m., Aug. 18.	5.30 a. m., Aug. 20.	37	4.45p. m., Aug. 22.	59¼	5.30 p. m., Aug. 25.	72¾
5.00 p. m., Aug. 18.	10.00 a. m., Aug. 20.	41	7.15 a. m., Aug 23.	69½	Died	
10.00 a. m., Aug. 19.	7.45 p. m., Aug. 20.	33¾	6.15 a. m., Aug. 22.	34½	5.15 a. m., Aug. 24.	47
10.00 a. m., Aug. 19.	5.30 a. m., Aug. 21.	43½	5.45 p. m., Aug. 22.	36½	7.30 a. m., Aug. 24.	37¾
1.00 p. m., Aug. 22.	9.45 a. m., Aug. 24.	44¾	5.30 a. m., Aug. 25.	19¾	Aug. 27	
1913.		*Days.*		*Days.*		*Days.*
Apr. 3[2]	Apr. 4	1	Apr. 7	3	Apr. 9	2
Apr. 2[2]	Apr. 4	2	Apr. 7	3		
Mar. 31[3]	Apr. 5	5	Apr. 16	11	Apr. 19	3

	Date of fourth molt.	Period between third and fourth molts.	Date of first young.	Period between fourth molt and birth of first young.	Entire immature period (approximate).
1912.		*Hours.*		*Hours.*	*Days.*
11.00 a. m., Aug. 14					
1.00 p. m., Aug. 14					
11.00 a. m., Aug. 14					
3.30 p. m., Aug. 14	Removed for description.				
3.00 p. m., Aug. 14	5.30 a. m., Aug. 21	48	5.15 a. m., Aug. 22	23¾	7½
4.30 p. m., Aug. 14	5.00 p. m., Aug. 20	23½	5.15 a. m., Aug. 22	36¼	7½
4.30 p. m., Aug. 14	1.00 p. m., Aug. 22	31½	6.00 a. m., Aug. 23	17	7½
6.00 p. m., Aug. 14	7.45 p. m., Aug. 20	38¼	5.15 a. m., Aug. 22	33½	7½
9.00 a. m., Aug. 15	5.30 a. m., Aug. 21	42	1.00 p. m., Aug. 22	31¼	7⅛
9.45 a. m., Aug. 15	8.00 a. m., Aug. 22	65¾	6.00 p. m., Aug. 24	58	9½
10.00 a. m., Aug. 15	1.00 p. m., Aug. 21	46½	1.00 p. m., Aug. 23	48	8⅛
10.15 a. m., Aug. 15	1.45 p. m., Aug. 21	46¼	4.00 p. m., Aug. 23	50¼	8¼
4.30 p. m., Aug. 18	2.15 p. m., Aug. 26	46¾	Aug. 28		9+
4.30 p. m., Aug. 18	Died				
5.00 p. m., Aug. 18					
10.00 a. m., Aug. 19	Removed for description.				
10.00 a. m., Aug. 19	8.15 a. m., Aug. 26	48¾			8+
1.00 p. m., Aug. 22	Aug. 29		Aug. 30		8
1913.		*Days.*			
Apr. 3[2]	Apr. 11	2	Apr. 14		11
Apr. 2[2]	Apr. 14		Apr. 17		15
Mar. 31[3]	Apr. 23	4	Apr. 24		24

[1] Winged female; all others wingless.
[2] Hatched from egg.
[3] Records by Gibson at Nashville, Tenn., in 1913.

It will be observed that only one record of a winged female was noted, and this individual required a noticeably longer time to reach maturity than did the wingless forms observed at the same time. This has been our observation time and again, although no definite records were kept.

AGE AT WHICH FEMALES BEGIN REPRODUCING.

In 1912 the age at which females began giving birth to young varied from 6 to 35 days, with an average of 10.3 days, from 38 records covering the months from May 15 to December. (Table V.)

TABLE V.—*Line of generations of Macrosiphum pisi from May 15, La Fayette, Ind., 1912.*

Cage number.	Generation.	Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Reproductive period.	Life after last young.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Date of death or disappearance.	Total length of life.
		1912.		*Days.*		*Days.*	*Days.*					*Days.*
First-born generation series:												
J	1	May 15[1]	May 24–25		June 13	20 or 21	1	59	2.8+ to 2.9+	5	June 14	
K1	2	May 30	June 11	12	July 5	25	2	60	2.4	5	July 7	38
K2	3	June 11	June 21	10	July 8	18	6	92	5.1+	10	July 14	33
K3	4	June 21	June 29	8	July 12	13	1	99	7.6+	14	July 13	21
K4	5	June 29	July 7	8	July 22	16	2	84	5.2+	10	July 24	25
K5	6	July 7	July 15	8	do	8		50	6.2+	11	July 22	15
K6	7	July 15	July 23	8	July 25	3		17	5.6+	8	July 25[2]	10
K7	8	July 23	Aug. 2	10	Aug. 22	21	4	72	3.4+	7	Aug. 26	34
K8	9	Aug. 2	Aug. 11	9	Aug. 20	10		88	8.8	12	Aug. 20[3]	18
K9	10	Aug. 11	Aug. 18	7	Aug. 22	5	3	38	7.6	11	Aug. 25[3]	14
K10	11	Aug. 18	Aug. 27	9	Sept. 8	13		69	5.3+	9	Sept. 8	21
K11	12	Aug. 27	Sept. 4	8	[4]							
K12	13	Sept. 4	Sept. 10	6	[4]							
K13	14	Sept. 13	Sept. 24	11	Oct. 12	19	1	50	2.6+	5	Oct. 13[3]	30
K14	15	Sept. 24	Oct. 10	16	Dec. 5	57	11	102	1.8−	10	Dec. 16	83
K15	16	Oct. 10 or 11	Oct. 30	19 or 20	do	37	11	58	1.6−	7	do	66 to 67
K17	17	Oct. 30 or 31	Dec. 4[5]	35	do	2		6	3.0		Dec. 16–20[6]	47 to 51
Last-born generation series:												
J1	2	June 13	June 24	11	July 10	17	3	54	3.2−	8	July 13	30
J2	3	July 10	July 21	11	Aug. 9	20	6	63	3.1+	7	Aug. 15	36
J3	4	Aug. 9	Aug. 18	9	Aug. 24	7		33	4.7+	8	Aug. 24	15
J4	5	Aug. 24	Sept. 1	8	Sept. 4	4		14	3.5	5	Sept. 4[3]	11
J5	6	Sept. 4	Sept. 11	7	Sept. 14	4	1	10	2.5	5	Sept. 15[3]	11
J6	7	Sept. 14	Sept. 24	10	Nov. 30	68		80	1.2−	9	Nov. 30	77
J7	8	Nov. 30	[7]									
Additional miscellaneous generation series:												
J1	2	May 24–25	June 6	12 or 13	June 28	23	7	41	1.8−	5	July 5	41 or 42
J2	3	June 6	June 17	11	July 4	18	3	63	3.8+	6	July 7	31
J3	4	June 17	June 28	11	July 14	17	3	106	6.2+	12	July 17	30
J4	3	June 24	July 1	7	July 18	18	7	119	6.6+	13	July 25	31
J5	5	June 28	July 5	7	July 19	15		94	6.3−	9	July 19	21
J6	4	July 1	July 9	8	July 15	7		41	5.9−	10	July 15	14
J7	6	July 5	July 13	8	July 21	9	1	37	4.1+	6	July 22[3]	17
J9	7	July 13	July 23	10	Aug. 7	16	1	33	2.1−	4	Aug. 8[3]	26
J10	6	July 19	July 27	8	Aug. 20	25	1	78	3.1+	7	Aug. 21	33
J11	4	July 21	July 26	5	Aug. 5	11	1	42	3.8+	7	Aug. 6	16
J12	8	July 23	Aug. 1	9	Aug. 23	23	1	72	3.1+	7	Aug. 24	32

J14	7	July 27	Aug. 6	10	Aug. 21	16	1	108	6.7+	12	Aug. 22	26
J15	9	Aug. 1	Aug. 12	11	Aug. 29	18	5	53	2.9+	6	Sept. 3	33
J16	8	Aug. 6	Aug. 15	9	Sept. 3	20	1	87	4.3+	10	Sept. 4	29
J18	9	Aug. 15	Aug. 23	8	do	12	1	57	4.7+	11	do	20
J23	8	Sept. 24	Oct. 10	16	Dec. 3	55	15	57	1.0+	9	Dec. 18	85

[1] Immature individuals collected in field; probably second or third generation from egg.
[2] Accidentally killed.
[3] Killed by fungus.
[4] By mistake progeny and life of single individual not kept.
[5] Placed in greenhouse Nov. 27 to hasten maturity. Transferred to outdoor shelter Dec. 4, after one mother had given birth to three young.
[6] Mother and young killed by cold.
[7] All viviparous and killed by cold.

The immature period varied from 7 to 56 days, between April, 1913, and January, 1914, with an average from 22 records of 15.3 days. (Table VI.)

TABLE VI.—*Line of generations of Macrosiphum pisi from stem-mother hatching from egg, La Fayette, Ind., Mar. 31, 1913.*

Cage number.	Generation.	Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Reproduction period.	Life after last young.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Date of death or disappearance.	Total length of life.
				Days.		*Days.*	*Days.*					*Days.*
First-born generation series:												
Pi-1	1	Mar. 31	Apr. 24	24	May 22	29	8	88	3.0+	8	May 30	60
Pi-2	2	Apr. 24	May 7	13	June 2	27	13	124	4.6−	11	June 15	52
Pi-3	3	May 7	May 21	14	June 16	27	13	90	3.3+	7	June 29	53
Pi-4	4	May 21	June 2	12	June 23	22	6	111	5.0+	11	do	39
Pi-5	5	June 2	June 14	12	July 3	20	4	59	3.0−	5	July 7	35
Pi-6	6	June 14	June 22	8	July 5	14	2	68	4.8+	7	July 8	24
Pi-7	7	June 22	July 1	9	July 14	14	5	39	2.8−	6	July 19	27
Pi-8	8	July 1	July 18	17	Aug. 1	15	3	29	2.0−	4	Aug. 4	34
Pi-9	9	July 18	July 30	12	Aug. 14	16	0	38	2.3+	6	Aug. 14	27
Pi-10	10	July 30	Aug. 7	8	Aug. 8	2	1	5+	2.5	5	Aug. 9	10
Pi-11	11	Aug. 8	Aug. 16	8	Sept. 1	17	8	70	4.1+	8	Sept. 9	32
Pi-12	12	Aug. 16	Aug. 25	9	Sept. 12	19	16	57	3.0	7	Sept. 28	43
Pi-13	13	Aug. 25	Sept. 3	9	Sept. 20	18	11	73	4.0+	8	Oct. 1	37
Pi-14	14	Sept. 3	Sept. 10	7	Sept. 18	9	1	27	3.0	5	Sept. 19	16
Pi-15	15	Sept. 11	Sept. 23	12	Nov. 6	45	9	104	2.3+	7	Nov. 15	65
Pi-16	16	Sept. 23	Oct. 6	13	Nov. 21	47	14	96	2.0+	10	Dec. 5	73
Pi-17	17	Oct. 6	Oct. 16	10	Dec. 15–22	61–68	0	60	1.0−	6	Dec. 22	77
Pi-18	18	Oct. 16	Nov. 22	37	Dec. 8	17	25	29	1.7+	4	Jan. 2[1]	78
Pi-19a	19	Nov. 25–29	Jan. 24[1]	56–60	[2]							
Last-born generation series:												
PiPi-2	2	May 22	June 3	12	June 28	26	2	92	3.5+	7	June 30	39
PiPi-3	3	June 28	[3]									
PiPi-9	9	July 31	Aug. 9	9	Aug. 17	9	1	27	3.0	6	Aug. 18	18
PiPi-10	10	Aug. 17	Aug. 25	8	Sept. 15	22	4	75	3.4+	10	Sept. 19	33
PiPi-11	11	Sept. 15	Oct. 3	18	Oct. 17	15	28	23	1.5+	3	Nov. 14	60
PiPi-12	12	Oct. 14–16	[4]									

[1] 1914.

[2] Discontinued. Kept out of doors until Jan. 19, 1914, at which time temperature was too low to allow further development. Hence they were brought into a warm greenhouse, maturing as viviparous females Jan. 24.

[3] The actual last-born generation series broken by death of female in cage PiPi-3, so the last-born young of experiment Pi-8 was used to continue the last-born generation series, the cage being numbered PiPi-9.

[4] Matured Nov. 14 and proved to be winged males.

An average of all experiments for the two years, carried through out of doors and apparently under normal natural conditions, was 12.1+ days. As would be anticipated, and as is shown in Tables IV and V, the age at which females began reproducing was shortest during the warmer parts of the year and longest during the early spring and late fall months. In the case where immaturity lasted 56 days the aphis would doubtless have remained immature for a much longer time, possibly all winter, had it been left out of doors under natural conditions. (See footnote 1, Table VI.) From 16 individual experiments, between March 23 and September 21, Mr. R. L. Webster (Folsom, 1909) found that a female begins to reproduce 11 days after birth, on an average.

REPRODUCTIVE PERIOD.

The reproductive period—that is, the time or period during which the insect gave birth to young—varied from 2 to 68 days in 1912 and from 2 to 61 days in 1913, or an average for the two years (53 examples) of 22 days. In computing these averages some records, where the aphis was known to have died from other than natural causes, were not considered. Except in cases where death was due to other than natural causes, the female almost invariably lived several days after the birth of its last young, the length of time varying from 2 or 3 to 28 days.

LONGEVITY.

As is the rule with all of the Aphididæ, the pea aphis lives for a much longer time in the spring and fall, especially in the fall, than in the summer. In our records the total length of life—that is, from date of birth to date of death—of individuals varied from 10 to 85 days in 1912 and from 10 to 78 days in 1913, or an average of 39.1+ days from 51 records made during the two years. Tables IV and V may be referred to for the variation in lengths of life at the different times of the year. In Mr. Webster's experiments reported by Dr. Folsom (1909) the length of life of 16 individuals from as many consecutive generations varied from 13 to 50 days, with an average of 25.4 days.

FECUNDITY OF VIVIPAROUS FEMALES.

The aphis under discussion is one of the most prolific of all plant-lice. We find that a female may give birth to as many as 14 young in a period of 24 consecutive hours. The average number of young per female for all individuals where records were kept in 1912 and 1913 (59 examples) was 3.7+ per day, but this is the average for the entire reproductive period of each female, and as we learned, the birth rate greatly diminishes toward the latter days of its life, often not averaging one young a day. Taking this into consideration we find the average birth rate during the active life of the mother

to be about 7 young per day, or even more. In our experiments individual females bore as many as 124 young, and Dr. J. W. Folsom (1909) reports a case where a single female produced 147 young. In Mr. R. L. Webster's experiment conducted at Urbana, Ill., in 1905 (Folsom, 1909) the average number of young borne by females of 16 consecutive generations was 46, while the average number of young produced by individual females in all our experiments conducted at La Fayette, Ind. (53 examples), excepting a few which were accidentally or prematurely killed, was 68.3+.

From these figures it is not difficult to see why this insect becomes so remarkably abundant, apparently within a few days, on its various hosts, and why it is able, collectively, to ravage and completely destroy crops almost before they become apparent to the casual observer.

SEXUAL FORMS.

Sexual forms may occur in the fall of the year, but there seems to be no uniformity in their production as is the case of certain other plant-lice. For instance, oviparous females may be produced by either wingless or winged females and the same female may produce both viviparous and sexual forms alternately; for example, in one of the experiment cages of 1912 a wingless female gave birth to her first young on October 10 and these proved to be oviparous females; later she gave birth to young which became viviparous females, and still later again bore oviparous females. A number of instances where females gave birth to viviparous and sexual forms alternately were observed in 1912 and 1913. Our earliest record of the birth of individuals of the sexual generation was October 10 in 1912 and October 14 in 1913. Dr. Folsom (1909) found the males in the field as early as October 10 in Illinois, and in one instance, in an experiment cage, an oviparous female was born as early as September 22. At Funkstown, Md., Mr. J. A. Hyslop observed the sexes of this species swarming on an alfalfa field November 12, 1912, the males and oviparous females predominating, although some viviparous females and young were observed. This observation was repeated at the same place by Mr. C. M. Packard October 28, 1913.

From these observations it is impossible to attribute the production of sexes to any particular cause. Certain aphids, notably *Aphis maidi-radicis*, *Sipha flava*, *Callipterus trifolii*, *Chaitophorus negundinis*, *Eulachnus rileyi*, etc., invariably produce the egg-laying forms toward winter in this latitude, and this may be attributed largely to the weather conditions; but in the case of *pisi*, both viviparous and oviparous forms are commonly borne of the same mother, and in the same line of generations, conducted under exactly identical conditions, reproduction may continue viviparously throughout the winter, while parts of one or more of these generations may become sexual forms. It is noted, however, that sexes are never produced

at any time except in fall or early winter, and climatic conditions no doubt have some direct or indirect influence.

In our experiments oviparous females were produced much oftener than males, probably accountable from the fact that individual males may fertilize several females. The oviparous females are invariably wingless; but we have found both winged and wingless males, the latter in only a few instances in 1911. In the field Mr. Hyslop also observed the wingless male. In the case recorded by him a winged and wingless male were attempting to mate with the same female. To our knowledge these are the only two records of the occurrence of wingless males in America.

Mordwilko (10) has observed wingless males in Russia, and in his writings has described this form.

Copulation takes place soon after the individuals reach maturity, and egg laying commences shortly thereafter. Eggs are laid on the stems and leaves of red clover, according to our observations in Indiana; but Mr. Hyslop, in his observations with this species on alfalfa, mentioned above, found eggs only on the leaves of alfalfa and in no case on the stems, petioles, or axils. We have no records of the sexual forms being produced or eggs being laid on any plants other than red clover and alfalfa. However, Mordwilko (10) has observed the sexual forms on *Medicago falcata*, *Lathyrus latifolius*, and *L. angustifolius*, and Theobald (11) found them on the flat pea (*Lathyrus sylvestris*).

FECUNDITY OF OVIPAROUS FEMALES.

Actual counts of the number of eggs laid by individuals were not made, but dissections of 12 unfertilized females several weeks after maturity showed that they were capable of laying an average of 25 eggs. (See Table VII.) These counts indicate that the fecundity of oviparous females of *pisi* is twice that of the average aphidid.

TABLE VII.—*Number of eggs of Macrosiphum pisi.*

Date.	Number of eggs laid previous to date of dissection.	Number of apparently fully developed eggs found in body.	Number of immature eggs in body.	Total number of eggs exclusive of undeveloped ones.
Dec. 6, 1912	1 or 2	27	2+	28 or 29
Do	1 or 2	24	Several	25 or 26
Dec. 10, 1912	Avg. of 2 per ♀	18		20
Do	do	25		27
Do	do	25		27
Do	do	19		21
Do	do	18		20
Do	do	25		27
Do	do	21		23
Do	do	17		19
Jan. 4, 1913	2	26		28
Do	2	30		32
Average		23		24.8+

NATURAL CONTROL.

It is doubtful if any species of plant louse is more harassed by enemies than is the pea aphis. According to the observations of other writers, which we are able to corroborate, the common aphis fungus, *Empusa aphidis* (fig. 13), is the most important natural check on the increase of *Macrosiphum pisi*. This fungus thrives under moist conditions, especially when accompanied by warmth, and hence it usually makes its appearance after a few days of rainy weather and more often in summer—that is, during the warmer months. As might be inferred, this fungus is contagious and spreads with wonderful rapidity, frequently, as observed by us, so completely eradicating the insects that it was difficult and sometimes impossible to locate a single living plant louse. Diseased aphids first turn brownish and later become covered with the fungus threads. Thus weather conditions favorable for the growth of Empusa fungus are indirectly important. Furthermore, driving rains destroy great numbers of these plant lice, and very hot, dry weather seems to

FIG. 13.—*Macrosiphum pisi* attacked by a fungus. Enlarged. (Original.)

FIG. 14.—The convergent lady-beetle (*Hippodamia convergens*), an enemy of *Macrosiphum pisi*: *a*, Adult; *b*, pupa; *c*, larva. Enlarged. (From Chittenden.)

hinder excessive multiplication, so that weather conditions are a great factor in the natural control of this pest.

Next in importance in the natural control of this aphidid are the ladybirds, and of these no less than nine different kinds are known to prey upon it, namely, *Hippodamia convergens* Guer. (fig. 14), which is probably the most generally common and abundant of all the ladybirds; *H. glacialis* Fab., *H. 13-punctata* L., *H. parenthesis* Say, *Cycloneda munda* Say, *Coccinella 9-notata* Hbst., *Megilla fusci-*

labris Muls., *Adalia bipunctata* L., and *Chilocorus bivulnerus* Muls. Both larvæ and adults feed on the plant lice.

The larvæ of the syrphid flies (Syrphidæ), more generally known under the name of "sweat bees," are important enemies of the pea

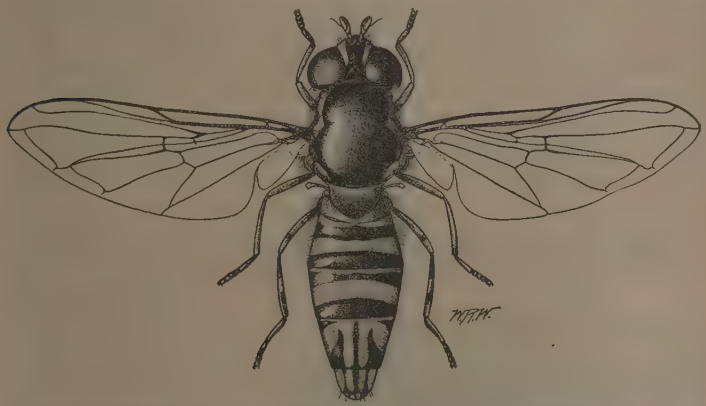

FIG. 15. *Allograpta obliqua*, a syrphid fly the larva of which preys upon *Macrosiphum pisi*. (Original.)

aphis. The larvæ are sluglike and attack the aphis by piercing it and sucking the body juices. Each larva is capable of devouring many aphides in rapid succession. Johnson reports (1899) that one grower in Maryland, when separating peas, sieved out about 25 bushels of syrphid larvæ, mostly of the species *Allograpta obliqua* Say (figs. 15, 16), which is illustrative of the abundance of these larvæ at times. The adult flies are everywhere abundant in summer, and especially in the neighborhood of heavy aphis infestations. They hover in the air and at brief intervals fly rapidly, but only for short distances. Folsom (1909) enumerates eight species as attacking *Macrosiphum pisi*, namely, *Ocyptamus* (*Baccha*) *fuscipennis* Say, *Platychirus quadratus* Say, *Syrphus americanus* Wied., *S. ribesii* L., *Allograpta obliqua* Say, *Mesogramma marginatum* Say, *M. politum* Say, and *Sphaerophoria cylindrica* Say.

FIG. 16.—*Allograpta obliqua*: Larva. Much enlarged. (From Metcalf.)

Three species of lace-wing fly larvæ (Chrysopidæ), namely, *Chrysopa oculata* Say, *C. rufilabris* Burm., and *C. plorabunda* Fitch, feed on this plant louse. They are predacious in the larval stage, as is the case with the syrphids. The larvæ are provided with a pair of hollow bow-shaped mandibles or jaws, with which they grasp the aphis and through which its juices are sucked. The adults are pale green insects with relatively large lacelike wings, and from this character the common name is derived.

A small pinkish or orange larva (fig. 17) belonging to the family Cecidomyiidæ (*Aphidoletes* sp.)[1] is an active enemy of this plant louse, and although of small size, being only about one-eighth of an inch long, it has a remarkable capacity and is very prolific. It is the more effective because it does not attempt to consume all of the body fluids, as do the syrphids and chrysopids, but seems only to feed upon the juices of the captive plant louse until the latter is dead, soon after which the dead plant louse is discarded and another one attacked. Doubtless the predacious larva mentioned by Fletcher as *Diplosis* sp. was an Aphidoletes.

Other insects which are known to be predaceous on *Macrosiphum pisi* are several true bugs (*Podisus maculiventris* Say, *Euschistus variolarius* P. B., and *Triphleps insidiosus* Say), a tree cricket, *Oecanthus confluens* H. & H., and a beetle, *Podabrus rugulosus* Lec. Another beetle (*P. pruniosus* Lec.), closely related to the last named, has recently been reported by Mr. H. F. Wilson (1913) as feeding on "the vetch aphis (*Macrosiphum pisi* Kalt.?)." A mite (*Rhyncholophus parvus* Banks) is also known to attack this aphidid.

FIG. 17.—Larva of the [illegible] fly [illegible], which preys upon *Macrosiphum pisi*. Enlarged. (Original.)

The pea aphis is attacked by several internal parasites. Aphides thus attacked are inactive and finally die, becoming brown in color, and the adult parasite makes its exit from the dead aphis by cutting a circular hole in the dried skin. The species hitherto reported attacking this aphidid are *Aphidius fletcheri* Ashm. MS., *A. washingtonensis* Ashm., *Trioxys* (*Praon*) *cerasaphis* Fitch, and *Megorismus fletcheri* Cwfd. In the spring of 1915 Mr. W. B. Hall of this bureau reared *Aphidius rosae* Hal. and *Praon simulans* Prov. of this species collected at Wakeman, Ohio.

METHODS OF ARTIFICIAL CONTROL.

In the clover field the pea aphis is ordinarily held in check by its natural enemies. If it is apparent that this aphis is becoming un-

[1] Since the above was written Dr. E. P. Felt has determined Aphidoletes reared at La Fayette, Ind., in 1915 from larvæ attacking *Aphis gossypii* as *A. meridionalis* Felt. There is little question but that the species attacking *M. pisi* is identical.

duly abundant, the clover should be cut as soon thereafter as possible, since the cutting and drying of the clover will kill most of the insects. Clover which becomes coated with the honeydew of the aphides will not cure properly. Spring pasturing or early cutting back of the clover will check the multiplication of this plant louse.

A more brief general discussion of the pea aphis was published by Dr. F. H. Chittenden as Circular No. 43 of the Bureau of Entomology under the title "The Pea Aphis (*Macrosiphum pisi* Kalt.)," February 25, 1909, pages 1–10. This publication is now out of print, but can be consulted in most agricultural college libraries, as well as public libraries, and in private ones. A farmers' bulletin covering the same subject is in course of preparation.

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CORRECTION.

Bulletin 276, U. S. Department of Agriculture.

On page 54 the legend to figure 17 should read as follows:

" Fig. 17.-Larva of the cecidomyiid fly Aphidoletes sp., which preys upon Macrosiphum pisi. Enlarged. (Original.) "

10 ng., 1909. (In Russian.)

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Page 8. Lists *Siph. pisi* on pea.

[1] Dates in italics refer to the more important references. Dates preceded by an asterisk indicate papers which have been inaccessible to the writer.

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Page 64. Describes *Siphonophora pisi* from specimens collected at Carbondale, Ill. Has not been observed in this country in injurious numbers.

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1900. Harvey, F. L. Notes on insects and plants. Maine Agr. Expt. Sta., Bul. 61, p. 31–44, March.

Page 31. Reports much damage to garden and field peas in Maine in 1899 by *Nectarophora destructor*.

1900a. Johnson, W. G. The destructive green-pea louse. *In* Canad. Ent., v. 32, no. 2, p. 56–60, fig. 4–6, Feb.

Description of winged and wingless viviparous females as *Nectarophora destructor* n. sp. Distribution of the species and its natural enemies.

*1900b. Johnson, W. G. [*Nectarophora destructor* John.] *In* Canner and Dried Fruit Packer, Feb. 15, p. 42.

Injuries, description, habits, and remedies.

*1900c. Johnson, W. G. [*Nectarophora destructor* John.] Circulars Maryland State Hort. Dept. No. 7 (May 12), No. 11 (May 15), No. 13 (May 31), No. 19 (June 3). Figs.

Describes condition of pest in Maryland and methods being used against it.

*1900d. Johnson, W. G. The green-pea louse in Maryland. *In* Amer. Gard., v. 21, no. 284, p. 375, June 2.

1900e. Johnson, W. G. The destructive pea louse. *In* Rural New Yorker, v. 59, no. 2636, p. 525–526, fig. 178–179, August 4. Also: *In* Strawberry Cult. (The strawberry root louse), v. 7, no. 1, p. 7, August.

1900f. Johnson, W. G. Notes upon the destructive green-pea louse (*Nectarophora destructor* John) for 1900. U. S. Dept. Agr., Div. Ent., Bul. 26, n. s., p. 55–58, 2 pl. Also: *In* 31st Ann. Rpt. Ent. Soc. Ontario f. 1900, p. 99–102

Destructiveness of the pea aphis, with notes on life history and methods of control.

1900g. Johnson, W. G. Notes on insects of economic importance for 1900. U. S. Dept. Agr., Div. Ent., Bul. 26, n. s., p. 80–84.

Page 81. Injuries occasioned by the pea aphis.

1900. Lugger, O. Bugs (Hemiptera) injurious to our cultivated plants. Univ. Minn. Agr. Exp. Sta., Ent. Div., Bul. 69, 259 p., 200 fig., 16 pl. Also: 6th Ann. Rpt. State Ent. Minn.

Page 201. Brief note on injuries in the East and in Wisconsin to peas by *Nectarophora destructor*.

1900a. Phillips, J. L., and H. L. Price. The nature and use of certain insecticides. Va. Agr. Expt. Sta., Bul. 97 (n. s., v. 8, no. 2), p. 11–26, February, 1899.

Page 23. Reports on damage by *Nectarophora destructor* in 1898–1899 and on insecticide tests against this insect.

*1900b. Phillips, J. L., and Price, H. L. The English pea louse. *In* South. Planter, v. 61, no. 4, April.

*1900a. Sanderson, E. D. [*Nectarophora destructor* John.] The destructive pea louse. *In* Amer. Grocer, v. 63, no. 8, p. 13–14, 2 fig., February 21. Also: *In* Amer. Packer, Canner and Dried Fruit Packer, February 15, p. 38, figs.

Description, injuries, habits, enemies, and remedies.

*1900b. Sanderson, E. D. The destructive pea louse. *In* The Canner and Dried Fruit Packer, March, 1900, figs.

1900c. [Sanderson, E. D.] The destructive pea louse. Del. Col. Expt. Sta., Press Bul. 4, 1 p., May 15.

Injury to peas in 1899. Occurrence on clover, mode of spreading to peas, and means of control.

1900d. [Sanderson, E. D.] The green-pea louse. Del. Col. Expt. Sta., Press Bul. 5, 1 p., June 1.

Injury to peas in 1900 in Delaware, susceptibility of different varieties, natural enemies, and control.

*1900e. Sanderson, E. D. The destructive green pea louse. *In* Rural New Yorker, v. 59, no. 2629, p. 413–414, fig. 126–130, June 16.

*1900f. Sanderson, E. D. Pea louse in Wisconsin. *In* Rural New Yorker, v. 59, no. 2644, p. 659, September 29.

1900g. Sanderson, E. D. Notes from Delaware. U. S. Dept. Agr., Div. Ent., Bul. 26, n. s., p. 66–72.

Page 69. Record of the pea louse during 1900. Records numerous enemies of this aphidid and gives remedies.

1900h. Sanderson, E. D. II. The destructive pea louse in Delaware. Del. Col. Agr. Expt. Sta., Bul. 49, p. 14–24, fig. 67, pl. 2–3.

Injury by *Nectarophora pisi*, its past history, brief description, food plants, spread of the pest, natural enemies, and means of control.

*1900. [Slingerland, M. V.] Pea lice in New York State. *In* Rural New Yorker, v. 59, no. 2649, p. 737, November 3.

1900a. Smith, J. B. Report of the Entomologist. *In* 20th Report of the Entomological Department of the New Jersey Agricultural College Experiment Station f. 1899, p. 423–512, 44 fig.

Page 424. First observed injury to peas by *Nectarophora destructor* in 1898. Notices of individual reports of damage by this insect in 1898, and suggests preventive measures.

1900b. Smith, J. B. Insects injurious to fruits. *In* Amer. Agr., v. 66, no. 25, p. 645, December 22.

*1900a. Webster, F. M. [Quoted in Phila. (Pa.) Public Ledger.] April 4, 1904.

Occurrences of the pea louse at Toledo, Ohio.

1900b. Webster, F. M. Insects of the year in Ohio. U. S. Dept. Agr., Div. Ent., Bul. 26, n. s., p. 84–90.

Page 88. Reports occurrence of *Nectarophora destructor* on Canada field peas, as well as red clover and garden peas, in various parts of Ohio. A fungus identified as *Empusa aphidis* destroyed myriads of the aphis.

1900. Weed, C. M. Insect record for 1899. N. H. Col. Agr. Expt. Sta., Bul. 72, p. 61–74, 11 fig.

Page 74. Reports damage to garden and sweet peas in various parts of New Hampshire, due to *Nectarophora destructor*.

1901. [Bureau of Entomology.] The principal injurious insects of the year 1900. U. S. Dept. Agr. Yearbook f. 1900, p. 725–729.

Page 726. Serious injury to peas by *Nectarophora destructor* along Atlantic coast and westward to Wisconsin. Remedies.

1901. Chapais, J. C. L'aphis des pois. *In* Nat. Canad., v. 28, no. 2, p. 17–20, Feb.

Reports serious injury to sweetpeas in August of 1900. Describes the insect (after Johnson). Observations of injury and remedies.

1901a. Chittenden, F. H. Remedies for insect pests in vegetable and flower gardens and conservatories. 4 p., 4 fig. Philadelphia.

Remedies for the pea louse.

1901b. Chittenden, F. H. The destructive green pea louse. U. S. Dept. Agr., Div. Ent., Circ. no. 43, 8 p., 3 fig., May 23.

A concise account of *Nectarophora destructor* Johns. as a pest of peas, under the following headings: Recent injury, descriptive, distribution, extent of injury and method of work, natural enemies, and method of control.

1901. Felt, E. P. Voluntary entomological services of New York State. *In* 16th Report of the State Entomologist on Injurious and Other Insects of the State of New York f. 1900 (Bul. N. Y. State Mus.), v. 7, no. 36, p. 1000–1026.

Pages 1003, 1017. Correspondent reports *Nectarophora pisi* not so injurious on Long Island as previous year. Also reported from Broome County.

1901. Fernald, C. H., and Fernald, H. T. Report of the entomologists. *In* 13th Ann. Rpt. Hatch Expt. Sta. Mass. Agr. Col. f. 1901, p. 84–88, Jan.

Page 87. Injury to peas by pea louse in 1900 but not so great as in 1899.

1901a. Fletcher, James. Injurious insects in Ontario during 1900. *In* 31st Ann. Rpt. Ent. Soc. Ontario f. 1900, p. 62–72, fig. 14–32.

Page 66. *Nectarophora destructor* not as abundant in 1900 as in 1899; notes reported injuries, remedies, and natural enemies.

1901b. Fletcher, James. Report of the entomologist and botanist. *In* Canada Expt. Farms Rpts. f. 1900, p. 195–249+ii, 18 fig.

Page 211. *Nectarophora destructor* was present in same districts as in the preceding year (1899) but in less injurious numbers. Notices of injuries and discussion of natural enemies, especially of the orange larva of a species of Diplosis.

1901c. Fletcher, James. Farm pests; fodder grasses. Evidence of Dr. James Fletcher, Entomologist and Botanist, before the Select Standing Committee on Agriculture and Colonization f. 1901, 25 p.

Page 20. Notice of injuries by the destructive pea aphis.

1901. Harvey, F. L. Notes on insects of the year 1899. *In* 16th Ann. Rpt. Maine Agr. Expt. Sta. f. 1900, p. 31–42.

Page 31. Reports *Nectarophora destructor* abundant and destructive to garden and field peas.

*1901a. Johnson, W. G. The destructive pea-louse. *In* Rural New-Yorker, v. 60, no. 2659, p. 17, fig. 7, Jan. 12.

*1901b. Johnson, W. G. Green pea industry threatened. *In* Amer. Agr., v. 67, no. 6, p. 202–203, 2 fig., Feb. 9.

1901. L., H. H. Pea louse in field peas. *In* Rural New-Yorker, v. 60, no. 2672, p. 267, April 13.

H. H. L. writes of field peas, grown with barley, being ruined in 1900 by the pea aphis. Suggests earlier planting.

1901a. Sanderson, E. D. Some plant lice affecting peas, clover, and lettuce. *In* Canad. Ent., v. 33, no. 2, p. 31–39, pl. 2, Feb.

Description of the winged and wingless viviparous female and winged male, together with comparisons with other species and supposed varieties. Concludes *pisi* of Europe and *destructor* of America identical.

1901b. SANDERSON, E. D. Danger from green pea-louse. *In* Rural New-Yorker, v. 60, no. 2692, p. 268, April 13.

Reply to correspondent who reports injury to fodder peas by the pea louse and of the successful use of whale-oil soap in combating it on garden peas.

1901c. SANDERSON, E. D. The destructive pea louse (*Nectarophora pisi* Kalt.). *In* 12th Ann. Rpt. Del. Col. Agr. Expt. Sta. f. year ending June 30, 1900, p. 169–186, fig. 8, pl. 2–3.

Account contains bibliography, description of the insect, past history, life history, injury, natural enemies, cause of outbreaks, and means of control.

*1901d. SANDERSON, E. D. Successful sprayer for the pea louse. *In* Rural New Yorker, v. 60, no. 2685, p. 481–482, fig. 204–205, July 13.

1901. SMITH, JOHN B. Report of the entomologist. *In* 21st Ann. Rpt. N. J. Agr. Expt. Sta. f. 1900, p. 479–572, 10 fig.

Page 505. General account of the life history of *Nectarophora destructor*. Review of known remedies and preventives.

1902. BRITTON, W. B. First report of the State entomologist. *In* Report of the Conn. Agr. Expt. Sta. f. 1901, pt. 3, p. 227–278+viii, 11 pl., 2 fig.

Pages 238, 276. The pea louse less abundant than in 1899 or 1900. Injuries and remedies.

1902. CHITTENDEN, F. H. The principal injurious insects in 1901. *In* U. S. Dept. Agr. Yearbook f. 1901, p. 674–679.

Page 675. The destructive pea louse not abundant except in a few isolated localities.

1902. FLETCHER, JAMES. Report of the entomologist and botanist. *In* Canada Expt. Farms Rpts. f. 1901, p. 197–262+ii, 19 fig., 1 pl.

Page 212. *Nectarophora destructor*, which occurred in Canada in injurious numbers in 1899 and 1900, almost entirely disappeared in 1901, one report only of injury being received.

*1902. JOHNSON, W. G. Protecting green pea crop from insects. *In* Amer. Agr., v. 69, no. 17, p. 584, April 26.

1902. PETTIT, RUFUS H. Some insects of the year 1901. Mich. State Agr. Col. Expt. Sta., Bul. 200, p. 179–212, 21 fig., May.

Page 198–200. Reference to injury in the United States and its occurrence in Michigan. Remedies.

1902. QUAINTANCE, A. L. Injurious insects of the year. *In* Rpt. Md. Hort. Soc. 4th Ann. Sess. held in Baltimore, Dec. 12 and 13, 1901, v. 4, p. 87–104, fig. 8–22.

Page 101. Less injury past year by pea louse. Injury most noticeable to late peas.

1902a. SANDERSON, E. D. Report of the entomologist. *In* 13th Ann. Rpt. Del. Agr. Expt. Sta. f. 1901, p. 127–199, fig. 13–33.

Page 168. Results of experiments in the control of *Nectarophora pisi* on peas.

1902b. SANDERSON, E. D. Insects injurious to staple crops. 295 p., 162 fig. New York.

Page 182. Brief account of *Nectarophora pisi*.

1902. SMITH, J. B. Report of the entomologist. *In* Ann. Rpt. N. J. Expt. Sta. f. 1901, p. 463–587, 36 fig.

Page 471. The pea louse was not so injurious as in 1900. Describes in detail a new sprayer adapted especially for this pest and efficacy of various remedies.

1902. WEBSTER, F. M., AND NEWELL, W. Insects of the year in Ohio. U. S. Dept. Agr., Div. Ent., Bul. 31, n. s., p. 84–90, Jan.

Page 87. Note on occurrence of the pea louse in Ohio.

1903. CHITTENDEN, F. H. The principal injurious insects in 1902. U. S. Dept. Agr. Yearbook f. 1902, p. 726–733.

Page 727. Reported damage by the pea louse negligible.

1903a. Felt, E. P. Importance of injurious insects introduced from abroad. *In* Report of the State entomologist on injurious and other insects of the State of New York for 1902 (N. Y. State Mus. Bul. 64), p. 116–126.

Page 122. Mentions *Nectarophora pisi* as an introduced species responsible for losses to pea growers in the Atlantic States.

*1903b. Felt, E. P. Importance of injurious insects introduced from abroad. *In* Proc. Soc. Prom. Agr. Sci., 24th Ann. Meet., p. 39–48.

1903. Fletcher, James. Report of the entomologist and botanist. Canada Expt. Farms Rpts. f. 1902, p. 169–201, 5 fig., 1 pl.

Page 179. Brief account of the destructive pea aphis. Worst attack the past season was on grass peas, hairy vetch, and field peas.

1903. Quaintance, A. L. Entomological notes from Maryland. U. S. Dept. Agr., Div. Ent., Bul. 40, p. 47–50, fig. 2.

Page 49. *Nectarophora pisi* was not injurious to peas past season (1902). Growers practice early planting to avoid injury.

1903. Smith, J. B. Report of the entomologist. N. J. Agr. Expt. Sta. Rpt. f. 1902, p. 425–508, 13 fig.

Page 425. Reports absence of pea louse in 1902, except on very late peas.

1904a. Britton, W. E. Third report of the State entomologist. Conn. Agr. Expt. Sta. Rpt. f. 1903, pt. 3, p. 199–286, fig. 27–42, 8 pl.

Page 212. *Nectarophora pisi* less abundant in 1903 than in 1902, though some injury to late peas.

1904b. Britton, W. E. Insect notes from Connecticut. U. S. Dept. Agr., Div. Ent., Bul. 46, p. 105–107.

Page 105. *Nectarophora pisi* less abundant than in 1902, but many late peas were injured.

*1904. Felt, E. P. Pea louse. *In* Country Gent., v. 69, no. 2673, p. 369, April 21.

Methods of controlling *Nectarophora pisi*.

1904. Fletcher, James. Insects injurious to Ontario crops in 1903. *In* 34th Ann. Rpt. Ent. Soc. Ontario f. 1903, p. 62–71, fig. 22–26.

Page 64. Reports injury to field and grass peas by the pea aphis.

1904. Pergande, Theo. On some of the aphides affecting grains and grasses of the United States. U. S. Dept. Agr., Div. Ent., Bul. 44, p. 5–23, 4 fig.

Page 21. The clover plant louse *Macrosiphum trifolii* is here described as new. Reports what he considers same species from wheat (*Triticum vulgare*), oats (*Avena sativa*), red clover (*Trifolium pratensis*), strawberry, sow-thistle (*Sonchus oleraceus*), and dandelion (*Taraxacum dens-leonis*).

1904–1906. Sanborn, C. E. Kansas Aphididae with catalogue of North American Aphididae and with host-plant and plant-host list. Pt. I–II. *In* Kans. Univ. Sci. Bul., v. 3, no. 1, p. 1–82, 22 pl., July, 1904, and v. 3, no. 8, p. 225–274, April, 1906.

Describes winged viviparous female of *Macrosiphum pisi* and reports taking it on rose. In the host plant catalogue the following hosts of *Macrosiphum pisi* are given: *Capsella bursa-pastoris*, cultivated beet, *Lathyrus odoratus*, cultivated pea, *Pisum sativum*, *Spiraea ulmariae*, *Trifolium repens*, *Urtica gracilis*, and *Urtica dioica*.

1904. Sanderson, E. D. Insects of 1903 in Texas. U. S. Dept. Agr., Div. Ent., Bul. 46, p. 92–96.

Page 96. Reports injury to garden peas in Texas by *Nectarophora pisi*.

1904 Smith, J. B. Report of the entomologist. *In* Rpt. Ent. Dept. N. J. Agr. Col. Expt. Sta. f. 1903, p. 557–659, 32 figs.

Page 563. Late peas were badly infested with the pea-louse.

1904. Stene, A. E. When to spray. Formulas and notes on spraying. R. I. Agr. Expt. Sta., Bul. 100, p. 121–148, 6 figs.

Page 129. Means against green pea louse.

1905. Chittenden, F. H. The principal injurious insects of 1904. U. S. Dept. Agr. Yearbook f. 1904, p. 600–605.

Page 604. Only few complaints of injury by *Nectarophora destructor* reported from Colorado.

1905. Felt, E. P. 20th Report of the State Entomologist on injurious and other insects of the State of New York f. 1904. *In* N. Y. State Mus., Bul. 97, p. 359–597, 24 fig., 19 pl.

Pages 408, 416. Brief notes on life history, natural enemies, and remedies for *Nectarophora pisi*.

1905. Fletcher, James. Insects injurious to grain and fodder crops, root crops, and vegetables. Canada Cent. Expt. Farm, Bul. 52, 48 p., 8 pl. June.

Page 27. Brief account of injuries by *Nectarophora pisi*, and remedies.

1905. Pettit, Rufus H. Insects of the garden. Mich. State Agr. Col. Expt. Sta., Dept. Ent., Bul. 233, 77 p., 65 fig.

Page 40. Host plants and remedies for *Nectarophora pisi*.

1906. [Bureau of Entomology.] The principal injurious insects of 1905. *In* U. S. Dept. Agr. Yearbook f. 1905, p. 628–636.

Page 629. A few reports of injury by *Nectarophora destructor*.

1906. Conradi, Albert F. Insects of the garden. Tex. Agr. Expt. Sta., Bul. 89, 52 p., 44 fig.

Page 4. *Nectarophora destructor* apparently widely distributed in Texas. Natural enemies and remedies.

1906. Fletcher, James. Report of the entomologist and botanist. *In* Canada Expt. Farms Rpts. f. 1905, p. 59–81.

Page 67. Refers to extensive destruction of pea crops in Canada in 1899.

1907. Bethune, C. J. S. Injurious insects of 1906 in Ontario. *In* 37th Ann. Rpt Ent. Soc. Ontario f. 1906, p. 45–56, fig. 3–17.

Page 49. Reports occurrence of plant lice on sweet peas.

1907. Hitchings, E. F. Second Ann. Rpt. of the State Entomologist of Maine f. 1906, 77 p., 19 fig., 1 pl.

Page 4. *Nectarophora pisi* reported from several localities in Maine.

1908. [Bureau of Entomology.] Principal injurious insects of the year 1907 U. S. Dept. Agr. Yearbook f. 1907, p. 541–552.

Page 544. *Macrosiphum pisi* reported rather more abundant than usual. Louisiana reported as a new habitat.

1908. Cæsar, L. The annual meeting of the entomological society of Ontario. *In* Jour. Econ. Ent., v. 1, no. 6, p. 397–401, December.

Page 399. Serious damage to the late peas by the pea aphis was reported. Aphis fungus effective in some localities.

1908. Gossard, H. A. Spring practice in economic zoology. Ohio Agr. Expt. Sta., Bul. 198, p. 15–88+viii, 9 pl., November.

Page 86. Brief description of *Nectarophora destructor*, its injury to peas, and remedies.

1908. Newell, Wilmon, and Rosenfeld, Arthur H. A brief summary of the more important injurious insects of Louisiana. *In* Jour. Econ. Ent., v. 1, no. 2, p. 150–155, April.

Page 153. Reports injury to cowpeas by *Nectarophora pisi*.

1909. Barre, H. W., and Conradi, A. F. Treatment of plant diseases and injurious insects in South Carolina. S. C. Agr. Expt. Sta., Bul. 141, 52 p., 1 fig.

Page 41. Means against green pea louse.

1909. [Bureau of Entomology.] The principal injurious insects of the year 1908. *In* U. S. Dept. Agr. Yearbook f. 1908, p. 567–580.

Page 571. *Macrosiphum pisi* was more injurious than for many seasons.

1909a. Chittenden, F. H. The pea aphis. U. S. Dept. Agr., Bur. Ent., Circ. 43, ed. 2, 10 p., 7 fig., Feb. 25.

Revised account of an earlier edition. See 1901, Chittenden.

1909b. Chittenden, F. H. Insects Injurious to Vegetables. 262 p., 163 fig., New York.

Page 114. Concise account of *Nectarophora pisi* as a pest to garden peas.

1909. Crawford, J. C. Notes on some Chalcidoidea. *In* Canad. Ent., v. 41, no. 3, p. 98–99, March.

Describes *"Megorismus Fletcheri"* n. sp., which was reared from *Nectarophora pisi* at Ottawa, Canada.

1909. Davidson, W. M. Notes on Aphididae collected in the vicinity of Stanford University. *In* Jour. Econ. Ent., v. 2, no. 4, p. 299–305, August.

Page 304. Reports *Macrosiphum pisi* from *Urtica holosericea* and Lathyrus. (The specimens from *Urtica* have been examined by the writer and prove not to be *pisi*. J. J. D.)

1909. Folsom, J. W. The insect pests of clover and alfalfa. Univ. Ill. Agr. Expt. Sta., Bul. 134, p. 113–197, 35 fig., 2 pl., April. Also *in* 25th Rpt. State Ent. Ill., p. 41–124, 35 fig., 2 pl.

Page 138. Important contribution, including distribution of the insect, its food plants, injury, descriptions, life history, habits, natural enemies, control, and bibliography of important literature.

1909. Gibson, Arthur. Insects of the year 1908 at Ottawa. *In* 39th Ann. Rpt. Ent. Soc. Ontario f. 1908, p. 116–120, fig. 31–32.

Page 119. *Nectarophora pisi* reported abundant on field and sweet peas. Notes parasite reared.

1909. Hunter, S. J. The green bug and its natural enemies. Univ. Kans. Bul., v. 9, no. 2, 221 p., 66 fig., 3 pl., folded tables 31–33.

Page 154. Unsuccessful experiments attempting to parasitize *Macrosiphum trifolii* with *Lysiphlebus tritici*. (Identification of the aphid doubtful. J. J. D.)

1909. Jarvis, C. D. Control of insects and of plant diseases. Storrs Conn. Agr. Expt. Sta., Bul. 56, p. 220–282, pl. 5–11, April.

Page 258. Remedies against pea louse.

1909. Newell, Wilmon, and Rosenfeld, Arthur H. Some common insects injurious to truck crops. State Crop Pest Comm. of La., Cir. 27, p. 93–131, 21 fig., July.

Page 108. Brief account of *Macrosiphum pisi*, including remedies and enemies.

1909. Swenk, Myron H. The principal insects injurious to horticulture during 1908–1909. *In* 40th Ann. Rpt. Nebr. Hort. Soc. f. 1908 and 1909, p. 75–128, 16 pl.

Page 104. *Nectarophora destructor* reported injuring sweet peas.

1910. Bethune, C. J. S. Observations on Ontario insects in 1909. *In* 40th Ann. Rpt. Ent. Soc. Ontario f. 1909, p. 63–67.

Page 63. Garden peas attacked by plant lice.

1910. DAVIDSON, W. M. Further notes on the Aphididae collected in the vicinity of Stanford University. *In* Jour. Econ. Ent., v. 3, no. 4, p. 372–381, fig. 28–29, Aug.

Page 380. Records *pisi* from *Vicia* sp., cultivated bean, and *Urtica holosericea*. (See notes under 1909, Davidson.)

1910. ESSIG, E. O. Aphididae of Southern California. V. *In* Pomona Col. Jour. Ent., v. 2, no. 4, p. 335–338, fig. 124–125, Dec.

Page 336. Describes winged and wingless viviparous female *Nectarophora pisi*.

1910. FULLAWAY, DAVID T. Report of the entomologist. *In* Ann. Rpt. Hawaii Agr. Expt. Station f. 1909, p. 17–46, 8 fig.

Page 23. Describes *Macrosiphum trifolii* Perg. from specimens collected on *Sonchus oleraceus*. (The writer has examined these specimens and they prove not to be *Macrosiphum trifolii* Perg. J. J. D.)

1910. GIBSON, ARTHUR. Reports on insects of the year. *In* 40th Ann. Rpt. Ent. Soc. Ontario f. 1909, p. 9–14.

Page 14. Occurrences of *Nectarophora pisi* on sweet peas but less numerous than in 1908. Parasite mentioned.

1910. PETTIT, R. H. Insects of field crops. Mich, State Agr. Col. Expt. Sta., Bul. 258, p. 36–84, 51 fig., February.

Page 47. Briefly noted as a pest on peas.

1910. ROSENFELD, ARTHUR H. Insects notably injurious in Louisiana during 1908 and 1909. *In* Jour. Econ. Ent., v. 3, no. 2, p. 212–217, April.

Page 214. Considerable injury by *Nectarophora pisi* but less than in 1907.

1910. SMITH, J. B. Annual Report of the New Jersey State Museum Including a Report of the Insects of New Jersey, 1909. Trenton.

Page 118. [Nectarophora] Throughout the State south of Piedmont Plain and seasonably abundant and destructive.

1910. SAUNDERS, WILLIAM. Report of the Division of Entomology and Botany. *In* Canada Expt. Farms Rpts. f. 1909, p. 37–64.

Page 56. Reports serious injury to garden, field, and sweet peas by *Nectarophora pisi* in Quebec and Ontario. Number of enemies noted, including a species of Aphidoletes and a new chalcid parasite (*Megorismus fletcheri* Crawf.) Remedies.

1910. WILLIAMS, T. A. The Aphididae of Nebraska. *In* Univ. (Nebr.) Studies, v. 10, no. 2, p. 85–175, April.

Page 168. Reported for clover in Nebraska.

1911. CÆSAR, LAWSON. Insects of the year in Ontario f. 1910. *In* 41st Ann. Rpt. Ent. Soc. Ontario f. 1910, p. 21–27.

Page 26. *Nectarophora destructor* reported destroying field of peas. Also report of cattle poisoning from eating infested vines.

1911a. DAVIS, J. J. List of Aphididae of Illinois, with notes on some of the species. *In* Jour. Econ. Ent., v. 4, no. 3, p. 325–331, fig. 10, pl. 10, June.

Page 330. Lists *pisi* from Illinois under names *trifolii* and *ulmariae*. White sweet clover is a new food plant listed.

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